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P. 13, line, 27, for "*O. quasigelidus*" read "*C. quasigelidus.*"
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P. 95, line 27, for "Lagos, S. Nigeria" read "N. Rhodesia."
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P. 145, second footnote, for "Liecester's types" read "Leicester's types."
P. 154, line 30, for "European" read "Ethiopian."
P. 155, line 16, for "Knowsby" read "Knowsley."
P. 190, line 22, for "Lutx" read "Lutz."
P. 193, line 28, for "not conspicuous" read "quite conspicuous."
P. 214, line 3, for "*boetica*" read "*baetica.*"
P. 269, line 18, for "Mr. J. A. Bovell" read "Mr. J. R. Bovell."
P. 295, fig. 2, delete legend and read "Antenna of *Silvius apiformis*, sp. n.: (*a*) dorsal view; (*b*) lateral view."
P. 326, line 8, for "*T. megacephalus*" read "*T. megacephala.*"
P. 341, line 2, for "one-third" read "one-half."
P. 352, line 28 } for "W. A. Patterson" read "W. H. Patterson."
P. 372, line 45 }
P. 362, line 8, for "**violaceus**" read "**violacea.**"

ENTOMOLOGICAL RESEARCH IN BRITISH WEST AFRICA.

V.—GOLD COAST.

By Jas. J. Simpson, M.A., D.Sc.

(*With a Map showing the distribution of* Glossina *and Sleeping Sickness, and* 8 *photographs by the Author.*)

(Plates I.—IV.)

Contents.

Introductory.

The following report is the fifth and last of a series dealing with entomological research in the British Possessions in West Africa. The other four have appeared in previous issues of this Bulletin, and in them the aims and methods adopted have been stated in considerable detail. This paper deals mainly with the results of personal observations on the geographical distribution of the various blood-sucking insects in the Gold Coast, made during a tour in that country from November 1912 to June 1913; with these are incorporated, wherever possible, records of previous workers in this line, and consequently the report may be taken as a general summary of entomological work accomplished in this Colony.

Several general considerations of the factors which influence insect distribution are here discussed, *e.g.*, a chapter has been added on the geographical position of the Colony, in so far as this determines the species of blood-sucking insects found; the physical configuration also calls for comment, as the mountains and rivers are factors of great importance in the distribution of such species; the nature and distribution of the vegetation also influence the types found in the different localities, and consequently a few short notes on this aspect have been added.

(C10) Wt.P12/42—26.3.13. 1,000. 3.14. B. & F.Ltd. G11/1. A

Lastly, a short discussion on the climate and rainfall, and its bearing on the subject in hand, has been given, for, as has already been pointed out, temperature, length and duration of the wet and dry seasons respectively, rainfall and humidity, are all factors in determining the occurrence of the different species of blood-sucking insects.

A map of the Colony is appended, and on it are shown (1) the extent and areas covered by the various types of vegetation, (2) the route followed by the author, (3) the localities in which the different species of *Glossina* were found, and (4) the distribution of sleeping-sickness. A number of towns and villages not shown on the original map, but referred to in the narrative, have been added in *red*.

The general narrative follows the order in which the country was traversed by the author. Since one of the chief aims in this survey was the visiting of as many European stations as possible, the main roads were for the most part followed; but at certain places deviations were made in order to enquire into special points suggested by information received from various officials. It will be seen from the map that the great majority of records are in the region traversed by the author; some of these, however, are based on observations made by others. But the most obvious feature is the abnormally small number of records from districts not on the main line of communication, showing how very little is known of the detailed distribution of any species, the local factors influencing it, and its significance. Surely this opens up a line of investigation which would be fraught with useful results.

A systematic list of the blood-sucking insects and other arthropods so far obtained in the Gold Coast is given as a guide to the species which may be expected, and, in the narrative itself, their local distribution is shown in some detail.

A few notes on the various diseases caused by blood-sucking insects, in man and other animals have been appended, and their distribution and prevalence discussed.

The general distribution of the various species of *Glossina*, and the factors which influence it, has also called for attention, but it must be remembered that this subject can be discussed only in very general terms, owing to our scanty knowledge of local prevalence.

Following up the introduction to the study of the parasites of mammals, birds, etc., started in my Report on Sierra Leone, I have collected together in a separate chapter certain records obtained during my seven months' tour in the Gold Coast. This is a subject which is of more than passing interest, and one which has not hitherto been sufficiently studied, owing in great part to the difficulty in obtaining specimens of the various types of game, &c.

It cannot be too strongly emphasised that this report must be taken in conjunction with the previous four, where many matters of general interest and application were discussed. After a more extended examination of West Africa I do not feel called upon to withdraw or modify any of the inferences there deduced or any of the recommendations there suggested, but on the other hand more strongly urge their adoption and extension in the Gold Coast.

I. Geography of the Gold Coast.

(1.) Position and Extent.

The territory in British West Africa administered under the name of the Gold Coast consists of three separate parts, (*a*) the Gold Coast Colony, (*b*) Ashanti, and (*c*) the Northern Territories. It is the most important country in West Africa (Nigeria excepted) on account of its immense agricultural and mineral wealth. It is situated in the middle of the Gulf of Guinea, and has an area of over 90,000 square miles, *i.e.*, almost as large as that of Great Britain; it is roughly rectangular in shape, and stretches inland for almost 400 miles from the coast. Its extreme boundaries south and north are 4° 45′ N. and 11° N., while its eastern and western limits lie in 1° 14′ E. and 3° 7′ W. The coast line extends for over 350 miles, and lies practically due east and west from Aflao to Newton.

The native population of the Gold Coast in 1911 was estimated at over 1,500,000, while in the same year 2,245 Europeans resided there. This latter number was made up as follows:—566 officials, 605 merchants, 922 engaged in connection with the gold mines, and 152 missionaries.

The three divisions mentioned above are arbitrary political divisions, but at the same time are to a great extent physical.

(*a*) The Gold Coast Colony.—The territory known under this name lies in the south, and contains the whole of the coast line. It has an average breadth of 250 miles, a depth inland varying from 50 to 120 miles, and comprises an area of approximately 24,200 miles. The geological formation and the nature of the vegetation divide the Gold Coast Colony into three main zones, (1) the Western, a country of forest-clad undulations; (2) the Central, a narrow tract of fertile hills; and (3) the Eastern, a country of plains covered with coarse grass and dotted with clumps of stunted trees.

The coast consists for the most part of a low sandy shore with occasional rocky cliffs, and is beaten, except at a few places, by a heavy surf. A number of small rivers occur at intervals; in the wet season these flow directly into the sea, but at other times, imprisoned by their sandy bars, they spread out into shallow stagnant lagoons. This is most marked between Addah and Kwitta. The Volta River alone has been navigated at its mouth by sea-going vessels, but only of small size and at great risk. There are no harbours for ocean-going steamers, and these are consequently compelled to anchor a half to one mile off shore. Along the 95 miles of shore in the Prampram, Addah and Kwitta districts, a narrow sandy spit separates the sea from the lagoons, which, with but two or three short breaks, extend beyond Lagos in Southern Nigeria.

The chief towns on the coast are Accra, Sekondi, Cape Coast Castle, Axim, Elmina, Addah, Kwitta, Saltpond, and Winneba.

Accra is the capital and seat of government of the Gold Coast, and has a population of about 21,000. It stands on sand and gravel some 25 feet above sea-level. Included within the municipal boundaries of Accra are Jamestown and Usher Town, in both of which are situated native quarters and commercial houses; Victoriaborg, the site of the European bungalows and most of the government

offices; and Christianborg, a native town, which also contains Christianborg Castle, the Residence of the Governor.

From Accra a railway is being constructed northwards through the cocoa-producing country in the Eastern Province. The sanitary condition of the town has been greatly improved during the last few years by the clearing of congested areas, the demolition of insanitary houses, the laying out of new streets, and a more thorough system of drainage. A water supply is being laid down, and when this is completed it will enable the sanitary authorities to do further good work in the way of exterminating mosquitos.

Sekondi is also an important town, inasmuch as it is the coast terminus of the Sekondi-Coomassie railway, which supplies the gold-mining district and the cocoa-producing country both of the Colony and Ashanti.

(*b*) Ashanti.—To the north of the Colony proper and separated from it by a very irregular line is the territory known as Ashanti. It has an average breadth of 250 miles, a depth inland varying from 50 to 120 miles, and an area of approximately 20,000 square miles. It is physically divided into the dense forest country of the south and the open grass country of the north. The forest zone is generally undulating and in places hilly, but in the open country the slopes are long and gradual.

The capital of Ashanti is Coomassie; it is the headquarters of a Chief Commissioner and a Provincial Medical Officer, and is the terminus of the railway from Sekondi; it is surrounded by swamps for some two-thirds of its circumference, but on the N.W. and S.E. it is connected by firm ground with the adjoining country, which is covered with forest, patches of bush, or elephant grass. Its water supply is amongst the best in the West Coast of Africa. The town is naturally well drained, for the ridge on which it stands is composed of ironstone and gravel merging into the loam of the swamps, and falls about 70 or 80 feet in a quarter of a mile.

(*c*) The Northern Territories.—This region comprises the hinterland of the Gold Coast, and lies, roughly speaking, north of the Black Volta River, which enters the Gold Coast from the French Ivory Coast, traverses it in an easterly direction, and eventually forms the boundary between the British and German territory. The area of the Northern Territories is estimated at 36,000 square miles. They lie wholly out of the forest belt, and may be described as a gently undulating plateau covered with savannah forest, with which is mingled open savannah. The capital of the Northern Territories is Tamale, which is the headquarters of a Chief Commissioner and a Provincial Medical Officer.

(2.) **Physical Configuration.**

Generally speaking, the country along the sea-board is undulating in character, especially to the east of Winneba, where extensive plains exist between the coast and the well-marked hill ranges in the interior, which approach, on an average, to within fifteen to twenty miles of the sea-shore. Westwards of the above-mentioned town the undulations are much more pronounced, and give rise to low hills with abrupt slopes facing the sea. The coast line is, on the whole, bold and well defined, and the long stretches of low-lying mangrove swamps, so characteristic of the Southern Nigerian coast, are here a very subordinate feature of the country.

As one recedes from the coast line northwards, the land becomes very hilly, well wooded, and rich in perennial streams, and these characters are maintained till the central plateau of Northern Ashanti is reached; there the dense forests gradually give way to the open savannah formation; in which the water supply during the dry season is poor, and the contours of the country again assume an undulating character. These upland plains are, however, dominated here and there by well-marked rocky hills that sometimes reach an altitude of 1,600 feet.

The plateau is interrupted by the lower valley of the Black Volta River to the north, but reappears a short distance inland from the left bank of that river, and gradually increasing in height, culminates in the tableland on which Gambaga is situated. It must attain an altitude of close on 2,000 feet in that province.

By far the most important river in the Gold Coast is the Volta, with its two large feeders, the Black and White Voltas. The former rises in the Mina Mountains of the Western Sudan, flows almost due south, and forms the boundary between the British Possessions and those of the French, from the 11th parallel as far south as about 8° 40′ north. At this point it enters the Gold Coast, and crosses the whole territory in an easterly direction, emerging in about 8° 10′ N. From that point almost to its mouth it forms the boundary between the Gold Coast and German Togoland.

The White Volta rises some hundred miles due north of the important town of Wagaduga, in the French Sudan, flows almost due south, and consequently drains a considerable portion of the Northern Territories. This river in turn is joined by the Red Volta, which also rises in the French Sudan and, after flowing southwards, joins the White Volta near Gambaga.

The River Daka, which also forms part of the boundary with Togoland, joins the Volta at the point where it emerges from the Gold Coast.

The most important tributaries on the right bank of the main or Black Volta within British territory, are the Tain, Pra, Sene, Sumi, and Afram Rivers, all of which, except the last, drain the northern portions of Ashanti.

As has been pointed out, the distribution of blood-sucking flies is to a great extent determined by the river systems, and the importance of this aspect with regard to the River Volta cannot be overlooked, since this river system connects the French Sudan, the French Ivory Coast, the Gold Coast, and Togoland, and in a smaller way, the Northern Territories and Ashanti with the Gold Coast Colony.

Three other rivers, though of much smaller size, also call for attention in this respect, namely, the Tano River, the Pra River and the Ankobra River.

The Tano River rises in north-western Ashanti, and after flowing in a more or less southerly direction for nearly the whole of its course, empties itself into the Tendo lagoon, on the extreme south-western border of the Colony, close to the town of Half Assini. It drains the forest land of Ashanti and the Colony, an area of several thousand square miles.

The Pra River, rising in the hills of Okwawu, in Eastern Akim, flows for the greater portion of its course in a south-westerly direction; at Sarmany it turns to the south and flows into the sea near the town of Shama; it drains an exceedingly hilly tract of country. The most important feeders on the right bank are the Anum

River, which drains the country to the east of the Sacred Lake, and the Offin, with its tributary, the Adra. These both drain the southern and south-western portions of Ashanti. On the left bank the Pra River is joined by two important tributaries, the Irwi and the Birrim, the latter of which is much the larger of the two, and drains one of the best cocoa-growing districts.

The Ankobra River rises in the extreme northern portion of Upper Denkira, close to the mining centre of Bibiani, and is confined for the whole length of its course to the limits of the Colony. It flows almost due south through a very rich mining and timber country, and falls into the sea close to Axim.

(3.) **Vegetation.**

For a detailed study of the vegetation of the Gold Coast the reader should consult a report* by Mr. H. N. Thomson. I shall here confine myself to a few notes on the various forest areas in so far as these have a bearing on insect distribution. The general limits of the different types are shown on the map which accompanies this report.

The chief plant associations in the Gold Coast are as follows:—Rain or moist tropical evergreen forests, fresh-water swamp forests, monsoon or mixed deciduous forests, savannah forests, and pure savannah.

The tropical rain forests contain trees of very lofty growth scattered amongst those of more moderate dimensions. As a rule, the trees in the rain forests are connected one with another by a regular network of climbers. Epiphytes are crowded all over the stems and larger branches. Several tiers of vegetation corresponding to the heights attained by the component species are to be met with, and under all a deep gloomy shade prevails, relieved only occasionally by spots of sunshine in clearings formed by the downfall of some forest giant. The air is saturated with moisture and is, as a rule, remarkably still—conditions very favourable to luxuriant forest growth. The dry season is of short duration, frequently interrupted by showers, and the Harmattan winds are feebly developed. This type of forest is, in its typical form, restricted on the coast line to the extreme south-west corner of the Colony, in the neighbourhood of Axim. From there it extends northwards (with one marked break) along the valleys of the Tano and Ankobra Rivers to just north of the 7th parallel. An extensive branch stretches from Axim in a north-easterly direction to Tarkwa. This is the type found in the greater part of Southern Ashanti.

The fresh-water swamp forests are composed of plants which have adapted themselves to growth in a permanently wet soil. They have much the appearance of plants inhabiting the rain forests, but are not so crowded, the formation being a comparatively open one. The swamps occur chiefly in the vicinity of the larger rivers, and are often caused by their overflow; they occur also in hilly country along some of the deeper valleys.

The monsoon or mixed deciduous forests are very rich in plants of economic importance. They are inhabited by both tropophilous and hygrophilous plants in

* Colonial Reports: Miscellaneous Col. 4993 Gold Coast: Report on Forests 1910.

varying proportions according to local variations in the rainfall and soil. Owing to the complete or nearly complete defoliation of the tropophilous plants during the dry season this form is easily distinguished from the rain and evergreen forests. This type is found in isolated belts in the Gold Coast.

The transition between the rain forest and the savannah forest is, on the whole, abrupt. This is accounted for by the fact that in the Gold Coast and Southern Nigeria the so-called dry season is tempered by frequent showers during the tornado months, which coincide with the vegetative periods of the grasses, and thus favours them at the expense of forest growth. In other words, owing to this feature of the climate, as soon as an area becomes, from the reduction in the annual rainfall, unsuitable for *luxuriant* forest growth it is appropriated by the grasses instead of by the intermediate stage represented by the typical monsoon forests.

The savannah forests constitute a park-like formation, rich in terrestrial herbs and more particularly in grasses. The tree growth is represented by arboreal tropophytes and evergreen xerophytes, but the latter are not numerous, and form an insignificant proportion of the vegetation. The density of the stock, so far as trees are concerned, varies in accordance with the nature of the soil and its telluric moisture. This type of forest, together with patches of scrub forest, are well represented on the south-east sea-board, whence they extend in a gradually narrowing belt as far west as Sekondi. To the north of Accra they follow the plain, and occupy the country up to the foot of the hills; then, sweeping round to the north, they follow the valley of the Volta River and gradually broaden out till, approximately at latitude 6° 30′ N., they rapidly increase in area, and, bending away to the north-east, occupy the northern half of Ashanti (from east to west) right up to the Volta River and practically the whole of the Northern Territories on the opposite bank.

Savannahs consist of formations in which trees are practically absent, and the dominant growth is represented by the grasses. They occur here and there among the savannah forests, and are not extensive.

Thorn forests are also poorly represented, and occur only in small patches, such as near Accra, and again in the Banda country of north-western Ashanti, within the savannah forest districts.

I hope to show later on that these forest formations are intimately associated with the distribution of the various species of *Glossina*. Reference to the map will show this to a certain extent.

2. Climate and Rainfall.*

As has been shown at considerable length in previous reports, temperature, humidity, and the length of the wet and dry seasons respectively have a distinct bearing on the distribution of the insect fauna, so that the following brief notes and tables have been prepared to show the main characteristics of the various regions.

* For a more detailed study of this subject see Report on Southern Nigeria in this Bulletin, Vol. iii, pp 145-155.

Table A.

Temperatures in 1910.

Station.	—	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Me
Accra ..	Solar Max.	146·5	41·9	142·8	146·9	148·0	151·2	149·0	149·3	153·3	152·2	146·1	143·9	147
	Shade Max.	85·9	86·6	86·3	85·9	85·3	84·3	84·3	82·0	86·0	87·1	87·3	87·2	85
	Shade Min.	62·1	63·4	66·6	61·1	62·7	65·7	62·6	62·7	62·0	65·1	68·9	71·2	64
	Range	23·8	23·1	19·7	24·9	22·6	18·7	22·0	19·3	24·0	22·0	18·4	16·0	21
	Mean	74·0	75·0	76·4	73·4	74·0	75·0	73·4	72·3	74·0	76·1	78·0	79·2	75
Aburi ..	Solar Max.	147·8	149·3	149·0	149·2	150·6	142·2	137·6	137·3	146·8	148·5	148·0	147·7	146
	Shade Max.	86·9	83·3	84·9	86·0	86·7	84·2	82·8	80·6	84·2	83·4	85·3	85·5	84
	Shade Min.	68·5	68·0	68·6	68·3	69·9	67·6	67·4	66·6	67·2	67·5	68·3	70·3	68
	Range	18·5	15·3	16·3	17·7	16·8	16·6	15·3	14·0	17·0	16·0	17·0	15·3	16
	Mean	77·7	75·7	76·7	77·2	78·3	76·0	75·1	73·6	75·7	75·4	76·8	77·9	76
Kwitta	Solar Max.	129·0	137·1	138·7	144·5	140·6	141·2	136·7	139·1	144·2	143·7	142·1	136·6	139
	Shade Max.	87·4	90·7	90·8	91·0	88·9	86·1	87·0	82·5	84·4	85·6	87·8	87·3	87
	Shade Min.	68·9	73·0	72·2	71·0	70·8	68·4	71·3	67·6	68·7	73·3	76·4	76·7	71
	Range	18·7	17·7	18·6	19·9	18·1	16·7	15·7	15·0	15·6	12·3	11·4	10·5	15
	Mean	78·2	81·9	81·5	81·0	79·8	77·3	79·1	75·1	76·5	79·5	82·1	82·0	79
Cape Coast	Solar Max.	135·7	142·4	147·2	144·7	145·4	141·0	142·9	145·5	147·1	147·3	143·8	145·5	144
	Shade Max.	85·4	88·8	89·8	88·2	87·8	85·9	83·4	82·8	83·0	85·1	86·4	86·9	86
	Shade Min.	71·9	72·9	73·5	72·8	73·0	72·0	71·2	66·6	70·8	71·3	72·1	73·4	71
	Range	13·5	15·9	16·3	15·4	14·8	13·9	12·2	16·2	12·2	13·8	14·3	13·6	14
	Mean	78·7	80·6	81·7	80·5	80·4	78·9	77·3	74·7	76·9	78·2	79·2	80·1	78
Sekondi	Solar Max.	128·2	133·9	136·5	142·2	134·4	132·0	132·2	129·2	130·4	134·9	—	—	133
	Shade Max.	87·5	90·0	91·9	90·9	91·2	87·8	85·8	82·6	82·8	86·5	89·5	90·2	88
	Shade Min.	69·4	72·6	72·7	72·5	72·8	72·2	71·1	69·7	70·6	70·9	72·1	71·7	71
	Range	18·2	17·5	19·1	18·4	18·4	15·6	15·0	12·6	12·2	15·5	17·4	18·5	16
	Mean	78·4	81·3	82·3	81·7	82·0	80·0	78·5	76·2	76·7	78·7	80·8	81·0	79
Axim ..	Solar Max.	147·8	133·1	131·7	131·2	130·7	130·1	131·0	131·1	130·8	131·5	130·4	131·7	132
	Shade Max.	87·0	88·4	88·4	88·0	88·0	84·7	84·1	83·3	82·0	83·1	85·6	87·2	85
	Shade Min.	68·5	67·2	67·6	67·2	66·8	66·6	66·5	65·6	65·4	65·4	66·5	66·7	66
	Range	18·5	21·1	20·7	20·8	21·2	18·1	17·6	17·7	16·6	17·7	19·1	20·5	19
	Mean	77·7	77·8	78·0	77·6	77·4	75·7	75·3	74·5	73·7	74·2	76·0	76·9	76
Tarkwa	Solar Max.	136·7	143·4	139·5	142·9	146·7	148·7	—	—	—	—	144·3	137·2	142
	Shade Max.	90·4	94·0	94·6	94·2	94·3	89·6	86·5	87·2	86·0	80·1	91·3	91·0	90
	Shade Min.	68·2	71·6	71·5	70·8	71·4	70·2	70·3	70·4	71·0	70·7	69·4	69·8	70
	Range	22·2	22·3	23·2	23·4	23·0	19·4	16·2	16·7	15·0	18·4	22·0	21·2	20
	Mean	79·3	82·8	83·1	82·5	82·8	79·9	78·4	77·8	78·5	79·9	80·3	80·4	80
Coomassie	Solar Max.	136·2	143·5	—	149·6	149·0	147·3	137·6	139·0	145·2	146·6	142·8	127·8	142
	Shade Max.	89·5	92·0	—	92·6	89·8	87·1	82·3	82·7	84·7	85·6	90·6	89·7	87
	Shade Min.	60·7	53·4	—	72·5	71·9	70·4	70·2	73·0	—	—	—	—	67
	Range	28·8	38·5	—	20·1	17·9	16·7	12·1	9·9	—	—	—	—	20
	Mean	75·1	72·7	—	82·5	80·8	77·8	76·2	77·8	—	—	—	—	77
Kintampo	Solar Max.	135·9	144·4	153·2	154·5	155·3	152·8	153·4	155·1	140·5	158·8	154·1	141·3	149
	Shade Max.	90·2	92·9	94·7	92·5	91·1	87·7	84·1	84·0	85·2	88·6	90·1	90·6	89
	Shade Min.	67·1	71·2	71·8	71·5	70·6	68·5	68·1	68·5	68·3	67·9	68·4	65·5	68
	Range	23·2	22·8	22·9	20·9	20·5	19·2	16·0	15·5	16·9	20·6	21·7	25·1	20
	Mean	78·6	81·5	83·2	82·0	80·8	78·1	76·1	76·3	76·7	78·3	79·3	78·0	79
Sunyani	Solar Max.	125·8	139·8	141·2	146·2	147·0	142 0	128·3	129·1	135·5	137·0	136·1	125·8	136
	Shade Max.	89·5	92·6	94·5	94·1	93·1	89·2	83·8	84·4	86·7	88·6	89·7	89·1	89
	Shade Min.	65·9	70·3	70·7	70·9	71·4	70·4	69·5	69·8	69·4	69·6	70·1	66·0	69
	Range	23·5	22·3	23·8	23·2	21·7	18·8	14·3	14·6	17·3	19·0	19·6	23·1	20
	Mean	77·7	81·4	82·6	82·5	82·3	79·8	76·7	77·1	78·1	79·1	79·9	77·5	79
Tamale	Solar Max.	139·3	152·4	152·2	146·5	147·8	143·0	135·9	136·5	143·2	152·6	151·2	147·0	145
	Shade Max.	96·4	102·6	104·0	100·6	97·8	93·0	87·4	87·0	89·2	94·6	97·0	96·2	95
	Shade Min.	55·7	61.7	65·5	64·2	63·2	60·4	57·6	58·3	57·1	59·4	57·5	55·3	59
	Range	40·6	40·8	38·5	36·4	34·6	32·6	29·8	28·7	32·1	35·2	39·5	40·9	35
	Mean	76·0	82·2	84·7	82·4	80·5	76·7	72·5	72·6	73·2	77·0	77·3	75·7	77
Gambaga	Solar Max.	—	158·5	156·8	156·0	151·8	109·0	—	—	104·1	115·8	—	146·6	137
	Shade Max.	—	98·9	102·8	101·7	99·0	92·7	85·5	84·6	87·1	93·7	—	99·3	94
	Shade Min.	—	78·8	75·5	76·4	74·5	72·6	69·9	70·5	69·9	71·0	—	69·1	72
	Range	—	20·1	27·4	25·3	24·5	20·1	15·6	14·2	17·3	22·7	—	30·2	21
	Mean	—	88·8	89·2	89·0	86·7	82·6	77·7	77·5	78·4	82·4	—	83·2	83

TABLE B.—*Temperatures from* 1905-1911.

	1	1905	1906	1907	1908	1909	1910	1911
Accra	Solar Max.	131·07	140·79	142·51	140·36	144·26	147·57	143·57
	Min. on grass	70·27	65·73	70·55	71·72	74·79	74·77	75·49
	Shade Max.	85·24	84·64	84·80	85·40	85·42	85·64	84·88
	Shade Min.	71·80	70·91	70·42	72·45	62·98	64·48	71·69
	Mean	78·52	77·77	77·61	78·92	74·20	75·06	78·08
Aburi	Solar Max.	145·59	141·61	144·47	148·92	146·93	146·14	145·34
	Min. on grass	69·90	70·61	70·29	67·96	61·89	66·31	66·65
	Shade Max.	86·83	81·12	87·11	85·76	83·91	84·47	84·21
	Shade Min.	71·11	73·57	71·07	67·55	67·52	68·18	67·78
	Mean	78·89	77·34	79·09	76·65	75·71	76·32	75·99
Kwitta	Solar Max.	140·64	140·93	139·31	141·32	139·64	139·46	139·01
	Min. on grass	73·06	70·12	71·55	72·26	69·93	60·35	73·12
	Shade Max.	89·90	90·11	87·85	89·32	88·33	87·44	85·50
	Shade Min.	76·20	72·75	74·95	74·55	72·28	71·52	75·00
	Mean	82·51	81·43	81·40	81·97	80·21	79·48	80·33
Cape Coast	Solar Max.	—	—	140·38	141·14	—	144·03	136·65
	Min.ongrass	72·10	73·99	71·81	70·72	69·72	60·25	58·95
	Shade Max.	84 25	84·84	86·54	86·45	85·59	86·11	83·64
	Shade Min.	73·96	75·95	73·36	73·05	71·81	71·77	71·31
	Mean	79·10	80·39	79·96	79·80	78·70	78·94	77·47
Sekondi	Solar Max.	141·55	140·54	138·53	139·10	135·38	133·39	141·37
	Min on grass.	72·57	72·38	72·77	72·72	71·62	67·01	66·92
	Shade Max.	85·23	86·48	86·14	86·46	87·17	88·07	86·30
	Shade Min.	73·53	73·27	71·71	71·86	71·62	71·53	70·49
	Mean	79·38	79·87	78·89	79·16	79·48	79·79	78·40
Axim	Solar Max.	135·52	138·95	135·81	132·05	130·86	132·57	130·43
	Min. on grass	64·18	62·16	57·12	65·17	71·91	72·04	68·81
	Shade Max.	83·71	86·20	85·11	84·45	84·25	85·80	82·31
	Shade Min.	71·23	70·27	68·41	67·99	67·13	66·66	65·53
	Mean	77·90	78·15	76·76	76·55	74·85	76·23	73·92
Tarkwa	Solar Max.	—	—	—	135·27	140·57	142·42	137·63
	Min. on grass	—	—	—	69·34	70·01	71·43	70·32
	Shade Max.	—	—	—	81·29	90·42	90·67	89·00
	Shade Min.	—	—	—	68·47	70·85	70·43	71·81
	Mean	—	—	—	72·75	80·64	80·55	80·40
Coomassie	Solar Max.	141·47	144·41	140·55	140·38	140·05	142·33	127·62
	Min. on grass	69·68	67·69	69·13	—	—	73·96	66·26
	Shade Max.	86·31	88·08	87·58	87·27	87·52	87·86	86·12
	Shade Min.	70·77	70·91	70·00	69·38	68·90	67·42	76·89
	Mean	81·03	79·49	78·79	78·32	78·21	77·69	77·99
Kintampo	Solar Max.	—	—	—	129·66	147·51	149·94	136·91
	Min. on grass	—	—	—	—	—	63·61	64·86
	Shade Max.	—	—	—	88·65	89·01	89·30	85·36
	Shade Min.	—	—	—	66·25	69·33	68·86	68·05
	Mean	—	—	—	77·45	78·77	79·08	76·70
Sunyani	Solar Max.	—	—	—	141·30	141·34	136·14	136·49
	Min. on grass	—	—	—	67·64	65·94	62·65	56·02
	Shade Max.	—	—	—	87·05	88·85	89·60	88·69
	Shade Min.	—	—	—	72·75	74·91	69·50	68·59
	Mean	—	—	—	79·90	81·88	79·55	78·65
Tamale	Solar Max.	—	—	—	145·13	143·19	145·63	148·08
	Min. on grass	—	—	—	—	74·25	58·33	20·28
	Shade Max.	—	—	—	92·93	94·74	95·46	94·33
	Shade Min.	—	—	—	69·14	63·05	59·66	59·28
	Mean	—	—	—	81·13	78·89	77·56	77·22
Gambaga	Solar Max.	146·97	148·34	149·65	149·35	152·54	146·72	153·08
	Min. on grass	66·34	70·74	61·77	62·19	68·57	69·06	68·51
	Shade Max.	91·56	88·68	88·81	90·87	92·42	94·51	93·43
	Shade Min.	72·47	74·49	73·97	72·26	71·82	72·78	70·76
	Mean	82·44	81·58	80·64	81·56	82·12	83·64	82·09

Tables A and B have been prepared as a basis for a study of the temperatures in the Gold Coast. These have been tabulated for twelve widely separated stations; in Table A the monthly records are given; while in table B the annual means for seven years have been brought together. From these it will be seen that the monthly temperatures are more equable along the coast than in the hinterland; in the southern parts there is not a very marked difference between the monthly means throughout the year; but in the north the wet and dry seasons are well defined in temperature as in rainfall. The highest monthly maximum attained in the Northern Territories is much greater than further south, and the lowest monthly minimum is also much less. The mean annual maximum temperature also increases gradually northwards. The range of the monthly means near the coast and in the forest region in Southern Ashanti is small, but increases rapidly in the Savannah region in the Northern Territories: *e.g.*, in Accra the monthly means vary only about 5° throughout the year, while in Tamale the range amounts to over 12°. In the former place the greatest average range for one month is 25°, while in the latter it is 41°; in the former the lowest average range is 16°, while in the latter it is 29°. The maximum range of temperature is experienced in November, December and January, and the minimum in August and September.

Table C shows the mean annual range of temperature for four stations from 1908–1911.

TABLE C.

Mean Annual Range of Temperature.

	1908	1909	1910	1911	MEAN.
Tamale	24·06	31·69	35·80	35·03	31·64
Coomassie ..	17·86	18·57	20·57	13·92	17·73
Aburi	18·33	16·39	16·29	16·42	16·85
Cape Coast ..	13·56	13·77	14·33	12·32	13·49

Tables D and E have been prepared for the same twelve stations as in A and B to compare the rainfall and humidity.

Station.	—	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean	Total.
Accra ..	Rainfall in inches	—	3·1	·9	2·1	4·1	18·6	3·2	2·4	·4	2·4	1·6	·7	—	39·5
	Degree of humidity	75·0	88·7	92·6	87·6	95·0	84·7	88·3	72·0	79·7	73·0	71·2	74·5	81·9	—
Aburi ..	Rainfall in inches	—	2·1	1·8	3·5	5·9	8·3	6·5	4·1	2·4	3·5	3·4	1·2	—	42·67
	Degree of humidity	87·7	87·1	88·7	86·4	87·7	85·7	86·5	87·7	87·7	88·6	87·7	86·9	87·4	—
Kwitta ..	Rainfall in inches	—	1·6	·1	·8	6·5	15·9	4·1	2·9	·8	6·4	1·4	·1	—	40·61
	Degree of humidity	73·0	79·8	72·1	71·1	79·9	86·3	79·7	80·0	76·1	75·8	53·1	83·9	75·9	—
Cape Coast.	Rainfall in inches	·7	·3	·9	3·2	1·7	9·3	4·9	1·7	1·1	1·2	·9	·03	—	25·99
	Degree of humidity	79·6	81·9	81·0	88·0	88·7	86·3	86·5	83·0	83·4	85·1	85·6	88·1	84·8	—
Sekondi	Rainfall in inches	—	·7	·6	3·2	4·4	11·8	8·6	3.5	2·9	3·6	·9	·5	—	40·7
	Degree of humidity	56·0	56·5	54·6	54.5	55·7	57·7	56·2	56·5	61·3	65·3	66·3	55·0	58·01	—
Axim ...	Rainfall in inches	—	1·8	3·0	10·8	11·6	22·9	14·6	5·3	5·5	5·4	9·6	·3	—	91·0
	Degree of humidity	87·7	92·1	91·2	84·9	90·6	90·6	92·6	92·5	93·4	92·8	90·0	90·0	90·77	—
Tarkwa	Rainfall in inches	1·1	2·0	4·5	5·3	9·7	11·7	7·1	7·7	6·3	11·1	7·0	5·3	—	78·81
	Degree of humidity	72·9	78·1	81·8	81·7	84·5	83·5	83·3	85.3	85·8	86·9	86·6	85·9	83·01	—
Coomassie	Rainfall in inches	—	1·7	—	3·9	10·9	7·4	10·0	12·9	12·6	9·5	2·0	—	—	70·89
	Degree of humidity	83·6	86·7	—	82·3	86·3	87·1	87·7	86·4	89·0	88·5	87·4	87·0	87·45	—
Kintampo	Rainfall in inches	—	2·3	2·0	4·7	6·7	6·5	10·2	7·4	21·0	11·1	·1	·4	—	72·27
	Degree of humidity	58·2	58·2	54·3	69·1	72·7	73·5	80·9	81·4	79·9	76·8	70·2	63·9	69·92	—
Sunyani	Rainfall in inches	—	1·8	2·5	8·2	6·1	5·6	6·7	13·3	5·9	9·5	·5	—	—	60·08
	Degree of humidity	84·2	92·2	91·4	89·9	90·5	90·8	91·4	93·1	88·2	87·2	83·3	80·3	88·5	—
Tamale ..	Rainfall in inches	—	·3	1·2	5·8	2·4	6·1	9·2	8·5	11·3	1·3	—	·3	—	46·21
	Degree of humidity	31·0	36·7	38·9	57·8	57·1	62·6	73·4	80·8	75·5	60·3	45·5	43·9	55·3	—
Gambaga	Rainfall in inches	—	—	1·6	2·2	2·3	4·6	12·7	14·2	10·3	1·1	—	1·5	—	50·58
	Degree of humidity	—	37·8	43·3	54·5	61·4	64·9	80·3	86·3	82·7	69·2	—	39·5	61·9	—

TABLE E.

Rainfall and Humidity.

		Accra	Aburi	Kwitta	Cape Coast	Sekondi	Axim	Tarkwa	Coomassie	Kintampo	Sunyani	Tamale	Gambaga
1905 ..	Rainfall in inches.	13	37	26	40	36	100	—	45	—	—	—	72
	Degree of humidity.	76	87	90	85	65	89	—	86	—	—	—	57
1906 ..	Rainfall in inches.	21	49	16	42	42	67	—	75	—	—	—	45
	Degree of humidity.	86	89	79	85	68	85	—	90	—	—	—	61
1907 ..	Rainfall in inches.	37	51	26	38	46	95	—	63	—	—	—	39
	Degree of humidity.	78	89	80	87	59	91	—	88	—	—	—	62
1908 ..	Rainfall in inches.	25	55	30	34	40	89	92	60	37	26	39	31
	Degree of humidity.	77	81	82	78	58	93	79	86	47	84	26	60
1909 ..	Rainfall in inches.	27	49	22	34	47	71	87	60	67	58	52	66
	Degree of humidity.	90	86	80	81	60	93	82	87	72	89	59	64
1910 ..	Rainfall in inches.	40	43	41	26	41	91	79	71	72	60	46	51
	Degree of humidity.	82	87	76	85	58	91	83	87	70	89	55	62
1911 ..	Rainfall in inches.	40	40	18	22	35	89	76	70	34	42	45	38
	Degree of humidity.	78	87	80	82	58	93	85	86	61	85	54	63

From these it is evident that the Gold Coast is the Colony of least rainfall in West Africa. In the coast region the maximum rainfall generally occurs in June and tails off rapidly; in Coomassie it is more evenly distributed from May to September; while in the Northern Territories, July, August and September may be taken as the months with the greatest rainfall. During these three months nearly three-quarters of the rainfall for the year occurs.

The smallest rainfall on the coast is in the low, sandy plains east of the Volta River; it increases westwards with the spread of the forest, culminating in the region around Axim. It is very heavy in the forest belt which passes through Tarkwa, but diminishes northwards where the monsoon forest gives way to savannah forest, and is least in the Northern Territories in the savannah region. The dry season proper in the hinterland is from November to April, when practically no rain falls.

The general humidity is least during the dry season, but is not proportionate to the rainfall. The towns on the coast, on account of their proximity to the sea, possess a higher relative humidity than the recorded rainfall would lead one to expect, and further, there is always a heavy dew and thick mist to about 8 a.m. in the rain- and monsoon- forest zone; this increases the relative humidity in these regions.

Thus when we compare the rainfall and humidity in 1911 of Kwitta on the coast, Coomassie in the forest belt, and Gambaga in the extreme north-east, we get the following figures: Kwitta, 18 inches of rain with a relative humidity of 80; Coomassie, 70 inches and 86; and Gambaga, 38 inches and 63 respectively.

The general humidity decreases from Axim northwards; at Kintampo at the edge of the forest this is very marked, while further north in the savannah region it is much more so. The difference between the relative humidity in the wet and dry seasons is much more marked in the northern parts; *e.g.*, in Axim in January and September, 1910, the figures were 87 and 93, while in Tamale, in January and August of the same year the figures were 31 and 80; the difference in the former was only 6, while in the latter it was 49.

Thus we see that in temperature, rainfall and relative humidity the Northern Territories show the extremes of a continental tropical climate, and are very comparable with the parts of Northern Nigeria in the same latitude.

III. Narrative.

(1.) **Accra to Lome (via Akuse).**

Accra, the capital of the Gold Coast, is situated a few miles west of the meridian of Greenwich and about 335 miles north of the Equator. The country around is level for some miles, and almost completely denuded of vegetation. Here and there one sees clumps of low bush, but of limited extent, and the whole area is extremely dry. The rainfall is low, and the heat during the dry season is intense. Until recently mosquitos were very troublesome, but owing to the efforts of the Sanitary Department, this nuisance is now very much in abeyance. During the rains, however, and to a less extent in the dry season, the following species have been caught:—*Aedimorphus punctothoracis*, *Ochlerotatus irritans*, *O. minutus*, *O. nigricephalus*, *Culex decens*, *C. grahami*, *C. guiarti*, *C. invidiosus*, *C. ornatothoracis*, *C. quasigelidus*, *C. thalassius*, *C. tigripes* var. *fuscus*, *C. fatigans*, *Culiciomyia nebulosa*, *Mansonioides uniformis*, *Stegomyia fasciata* and *Uranotaenia mashonaensis*. The number of individuals found is, however, not nearly so great as this formidable list would suggest.

Until very recently Accra was regarded as an area free from tsetse, where ponies could be kept without fear of trypanosomiasis, but within the last few years both *Glossina palpalis* and *G. longipalpis* have been captured, and more than one pony has suffered from this disease. Whether this was contracted in Accra or not is, however, uncertain.

I hope to go into this subject in greater detail later on, so will only draw attention here to a few entomological observations made during my stay at Accra.

There is no evidence to show that either of these species of tsetse breeds in or near Accra, but it is fully proved that both are introduced from the surrounding country by trains and motor waggons. In order to study this problem I made three journeys into the country beyond Accra: (*a*) to Nsawam, at that time the railway terminus; (*b*) to Weshiang, the site of the new water supply for Accra, which is connected with the latter town by a light railway; and (*c*) to Dodowa, along a road which is traversed daily by motor waggons.

(*a*) To Nsawam.—For the first five miles the country consists of undulating open grass plains of the pure savannah or thorn forest type, with occasional clusters of

bush. There is no telluric moisture in such a region and no shade of any consequence. Near Dome station the dense vegetation begins, and here *G. palpalis* was caught in the railway carriage. Thereafter to Nsawam a distance of 30 miles from Accra, the bush gradually becomes more dense; the town of Nsawam is situated in a forest clearing (Plate III, fig. 1). *G. palpalis* was also seen here. The river Densu rises near Nsawam and flows through Weshiang, and it is from this river that the new water-supply for Accra is taken.

(*b*) To Weshiang.—This locality is about 11 miles from Accra. The country for the first 7½ miles is similar to that described from Accra to Dome, but near the village of Oblogo is the commencement of a *G. palpalis* belt. This continues to Weshiang, and it is more than probable that *G. palpalis* occurs all along the Densu River to Nsawam. Around Weshiang there is an extensive undulating grassy plain with clusters of palms and bush, and there *G. longipalpis* occurs.

Mansonioides uniformis occurred in thousands at the waterworks camp during my visit, and in all probability they breed in the dam formed in the Densu river in connection with the works (Plate IV, fig. 1). Dr. Ingram found that in Bole the larvae and pupae of this species were to be found in fairly clear water where there were no overhanging trees or grass, but in which a water weed (*Pistia stratiotes*) flourished, to which both larvae and pupae clung tenaciously. This is very important, inasmuch as it opens up a new source of trouble and shows that when any such open expanse of water must be retained, it is not sufficient to cut down the surrounding vegetation, but the whole area must be kept free from this weed. This should be kept in view in connection with the new dams and reservoirs at Weshiang.

(*c*) To Dodowa.—A large well-made road, suitable for motor transport, connects Accra with Dodowa, a distance of 27 miles, and is daily traversed by motor waggons belonging to the trading firms. For the first 10 miles or so the country is as open as before, but near the village of Adinta it is covered with low bush. Two specimens of *G. longipalpis* entered the motor during a halt made at this village, and at Dodowa itself *G. palpalis* was caught.

Thus we see that at distances varying from 5 to 12 miles from Accra both *G. palpalis* and *G. longipalpis* occur, and that these enter both railway carriages and motor waggons, and are thus transported into Accra. It is difficult to say at present whether these will actually find suitable breeding grounds in or near the town, but their presence is a distinct menace to the safe keeping of ponies. Trapping at and near the railway station should be resorted to, and it would be interesting to find out the percentage of sexes caught.

Other blood-sucking flies caught at Accra include *Stomoxys calcitrans, Tabanus biguttatus, T. ditaeniatus,* and *T. taeniola.* At Dodowa in addition to *G. palpalis, Chrysops longicornis* and *Hippocentrum trimaculatum* were captured.

Aburi is situated about five miles from Dodowa, and is about 1,500 feet above sea-level; the ascent is very steep and the hill is densely wooded. Here are situated the headquarters of the Agricultural Department and the Government Sanatorium. *G. palpalis* was encountered about half-way between Dodowa and Aburi. Other blood-sucking flies from this region are *G. fusca, G. pallicera, Stomoxys omega, Hippocentrum trimaculatum, H. versicolor, Haematopota grahami, H. torquens, Tabanus taeniola, T. socialis, Culiciomyia nebulosa, Eretmopodites*

chrysogaster, *Ochlerotatus nigeriensis*, *Stegomyia simpsoni* and *Taeniorhynchus metallicus*.

Between Dodowa and Akuse the country is fairly level and, for the most part, open. *G. longipalpis* was caught near Agomeda. Akuse is at present the headquarters of the Provincial Commissioner of the Eastern Province, also a District Commissioner, Medical Officer, and a Superintendent of Police. It is a very important trading centre. The country for a few miles around is a level plain denuded of all trees, and only small patches of bush or open savannah occur. No tsetse have so far been seen in this area.

About two miles from Akuse, on the right bank of the Volta, is the town of Amedika, and, except during the height of the dry season, small launches ply between this town and Addah at the mouth of the Volta River, 71 miles further down. The banks of the river at this part are high and steep, and are covered with dense vegetation and high overhanging trees, except at the crossings, where small clearings have been made. *Glossina palpalis* is everywhere abundant along this part of the river, and sleeping sickness has been reported from this area.

Addah is an important trading station at the mouth of the Volta River, and is the only port in the Gold Coast which is connected directly with ocean-going ships by means of small steamers. There is a very extensive mangrove swamp at the mouth of the river and for some distance up. *G. palpalis* occurs everywhere in this swampy area, and in addition to these *Tabanus biguttatus* var. *croceus*, *T. ditaeniatus* and *T. taeniola* have been caught. Mosquitos are said to be very troublesome during the rainy season; the two most prevalent species are *Anopheles costalis* and *Mansonioides uniformis*.

The first part of the journey from Addah to Kwitta is made by launch to Atitite on the left bank of the river. From that point onwards the road follows a long sandy spit, never more than a few miles wide, which separates the sea from an extensive inland lagoon; this lagoon extends, with a few breaks, to beyond Lagos in Southern Nigeria. Soon after the rains are finished it begins to dry up, and at the height of the dry season only a few foul-smelling pools remain. Mosquitos are said to be very prevalent in the rains, the two most abundant species being *Anopheles costalis* and *Mansonioides uniformis*. Other blood-sucking flies obtained there are *Lyperosia minuta*, *Stomoxys calcitrans* and *Tabanus taeniola*.

The road from Kwitta to Lome, the capital of German Togoland, follows the same sandy spit mentioned above. Near the frontier is the town of Denu, where is situated a Government bungalow. Formerly this was an important trading post. The following species of mosquitos breed there:—*Anopheles costalis*, *A. funesta*, *A. paludis*, *A. pharoensis* and *Mansonioides uniformis*.

(2.) **Obosomano to Akuse.**

This journey was made partly by road and partly by canoe. The River Volta, as far as Wupe, forms the boundary between the Gold Coast and Togoland.

Obosomano is one of the Volta stations of the Preventive Service, and is situated near the mouth of the Obosom River. *Glossina palpalis* was everywhere abundant in this region, even in the Preventive Service quarters. At the time of my visit, about the middle of December, the River Volta was very low and many pools were left by the receding water; in several of these pools mosquito larvae were found

exposed in a few inches of water to the full blaze of the sun. The vegetation on the river banks is very dense and practically no clearing has been made around the station.

Nkami, about 18 miles further south, is the next Preventive Service station. The road runs parallel to the river about a quarter of a mile from it. Between the road and the river the vegetation is best described as a fringing forest, but inland from the road the country is open and park-like in character. This whole area is burnt during the dry season. Several dry water-courses occur in this region, and these are also fringed by thick bush. At several of these *G. palpalis* was captured, and at one place *Tabanus taeniola*. *G. palpalis* was also found in the Preventive Service quarters at Nkami. Between Nkami and Fasu, the next Preventive Service station, and onwards to Wupe, the road and country are similar to that described above. *G. palpalis* was everywhere abundant along the course of the river, also in the European quarters of Fasu and Wupe.

At Wupe I managed to obtain canoes, and the remainder of the journey was accomplished by river. From Dodi I visited the Sleeping Sickness Camp at Anum, situated on a high hill commanding an extensive view of the river and surrounding country. No tsetse have been seen on this hill. At the time of my visit there were no sleeping sickness cases in the hospital.

A return to the river was made *via* Labalaba, one of the experimental stations of the British Cotton-Growing Association. *G. palpalis* was met with in this region, and the site on which the European bungalow was built is low-lying and altogether unfit for occupation.

The journey from Labalaba to Kpong was made by canoe; *G. palpalis* was very troublesome all along this part of the river. From Kpong to Akuse a new road is being made, but a great part of this region is under water during the wet season. On this section of the river there is a continual intercourse between the Gold Coast and Togoland, and smuggling is always being attempted. There is a large number of native Preventive Police at the various stations, and the whole region is patrolled by European Preventive Officers. There are no regular well-cleared ferries, nor is the clearing around the stations by any means adequate, although the stations themselves are exceedingly well kept. Extensive clearing at the important crossings and around the stations is strongly to be recommended, especially as sleeping sickness is by no means uncommon in this region.

(3.) **Akuse to Coomassie.**

This route traverses the Birrim District of the Colony and the southern part of the Central Province of Ashanti. There is no regular road, so that the native bush-paths connecting the various villages had to be followed. This made the trek a very sinuous one, and many hills were crossed.

Between Akuse and Somanya the country is level and open, and similar to that between Akuse and Dodowa. After Somanya several high hills have to be crossed, and the vegetation is much more dense. Near the town of Asamang about half-way to Komfrodua *Glossina palpalis* was found. From Komfrodua to Tafo the country is fairly level, and everywhere there is a thick bush. No blood-sucking insects were seen during this trek.

From Tafo I visited Kibbi, the headquarters of the Commissioner of the Birrim District and also the site of an Agricultural Station. The country is hilly, covered with thick bush and numerous high trees. At Kibbi *G. palpalis* and *Tabanus secedens* were caught, while sand-flies (*Culicoides grahami*) were a regular scourge between five and six in the evening. At a small place called Pusu Pusu the plant for a new gold-mine was being laid down, and *G. palpalis* is far from uncommon in this region. At Boonso there is a large rubber and kola estate, and from Mr. Anderson, the curator, I obtained several specimens of *G. fusca* and *T. secedens*, both of which species he avers to be common at certain times of the year. On the Birrim River at the same place I caught *G. palpalis*.

From Boonso I went to Anyinam, which stands on the Birrim River. *G. palpalis* swarmed at this place and numbers followed the women from the watering-place to the town, invading the rest-house *en route*. *Tabanus secedens* was also caught at the river, while *Culiciomyia nebulosa* swarmed in hundreds in the rest-house. These were breeding in a latrine pan containing a small quantity of water. When such pans are kept in grass-roofed houses they should be inverted when the rest-house is not occupied.

The road from Anyinam to Jyagate passes through dense bush and high trees, and numerous streams and swamps were crossed. *G. palpalis* and *Hippocentrum trimaculatum* were caught during this trek, and one jigger, *Dermatophilus penetrans*, was taken from a native's foot.

After Jyagate the country is level to near Mpraeso, where a very steep escarpment is encountered. After climbing this, one reaches an enormous flat plateau on which Mpraeso is situated. Many of the Moshi cattle which are driven from the Northern Territories to the coast pass through Mpraeso. These are generally swarming with *Hippobosca maculata* which follow cattle for hundreds of miles. These cattle also serve as tick disseminators. At Mpraeso a new species of *Tabanus*, near *T. besti*, was obtained.

After leaving Mpraeso the above-mentioned escarpment is again encountered and the descent to Kwashilo is exceedingly steep, but after that point the road is undulating. This part of the country is thickly forested. Near Asangare the following were caught:—*Glossina fusca*, *Tabanus secedens* and *Haematopota torquens*. *Hippobosca maculata* were also seen in numbers on the cattle in transit.

From Asangare I went to Odumase, *via* Bompata. This part is well within the rain forest belt, and there are numerous streams which retain water throughout the dry season. *Glossina fusca* and *Haematopota torquens* are both common in this region.

After Odumase the River Anum, a tributary of the Pra, has to be crossed near the town of Anum Praso. Here *G. palpalis* and *Stomoxys calcitrans* were obtained, while after crossing the Anum River both *G. palpalis* and *G. fusca* were met with near Beposo.

The next halt was made at Konkoma, a small filthy town on the Sacred Lake Bosumtwe. This is a most peculiar lake, almost circular, and nearly five miles in diameter, surrounded by an isolated range of hills. There is no outlet and the approach from all sides is steep. Several small fishing villages are situated on its banks. The shores of the lake and the lower slopes are covered with long grass, but the upper slopes carry thick bush. The only blood-sucking insect seen here was

Stomoxys calcitrans; fish are abundant in the lake, and this may account to a great extent for the absence of mosquitoes.

The first part of the road from Konkoma to Coomassie is round the lake shore, then there is a steep ascent over the range of hills; but after that the road is undulating, through heavy forest. *Glossina palpalis* was caught at Jakye, and this was the only blood-sucking insect seen during this trek.

It must be remembered, however, that this journey was accomplished between January 1st and 21st, at the very height of the dry season, when insect life is at its minimum.

(4.) Coomassie to Tamale.

A general description of Coomassie has been given on page 4. Its great importance lies in the fact that it is the capital of Ashanti, the headquarters of the West African Frontier Force and the terminus of the Sekondi-Coomassie Railway. It is also a large and important trading centre. Blood-sucking flies are by no means abundant in Coomassie, and it is noteworthy that the most prolific genus is *Stomoxys*; no fewer than five species, namely, *calcitrans*, *brunnipes*, *inornata*, *nigra* and *omega* have been caught there. Other blood-sucking flies are *Chrysops longicornis* and *Tabanus thoracinus.*

Over 60 ponies were quartered in Coomassie during my stay there, and this may account for the preponderance of *Stomoxys*, which is essentially a stable fly. Several of these ponies had trypanosomiasis, but in all probability this disease was contracted before their arrival at the station. Treatment with atoxyl by mouth and injection was carried on with good results. An occasional tsetse has been caught in Coomassie, but there is little doubt that these were transported there.

A large number of cattle are brought into Coomassie daily from the north and these are generally covered with *Hippobosca maculata*, which rise from them in clouds; most of them also carry numerous ticks, chiefly *Amblyomma variegatum.* Dr. Montgomery, the Provincial Medical Officer examines the blood of all those killed for the butcher, and from a very large number of cases states that fully eighty per cent. are infested with trypanosomes.

From Coomassie to Ejura there is a large well-made road suitable for motor traffic. It passes to within a few miles of Ejura through dense primeval forest, but near the latter place, after the River Afram is crossed, a long steep ridge has to be traversed, and this marks the transition from rain forest to savannah forest. From this ridge miles of surrounding country can be seen, covered with grass interspersed with clusters of Borassus palms and widely separated decidous trees. The first rest-house on this road is at Kona and there sand-flies (*Culicoides grahami*) were extremely abundant. They seldom trouble one before 4 p.m. and generally disappear about 7 p.m. *Hippobosca maculata* and *Amblyomma variegatum* were obtained from the cattle which pass along this road in large herds *en route* for Coomassie.

At Mampon *Culicoides grahami* was also abundant, and on the cattle, in addition to the species of tick mentioned above, *Boophilus decoloratus* was also found. Several *Hippobosca maculata* were seen on my pony and a bug *Clinocoris hemiptera* (*Cimex rotundatus*), was obtained in a native hut. Not far from Mampon *Glossina palpalis* was found near a stream. The only blood-sucking fly seen between Mampon and Edijan was *Hippobosca maculata.* Between Edijan and Ejura, at the River

Afram, *Glossina pallicera* was found, while at Ejura itself both *G. longipalpis* and *G. morsitans* occur. It is noteworthy that the latter species was found immediately after entering the savannah forest country.

From Ejura to Yeji the country is open and park-like in character. Large numbers of cattle, sheep and goats, as well as donkeys carrying loads, were everywhere seen on this road, with their accompanying hosts of *Hippobosca maculata*. *Glossina palpalis* was found on a tributary of the Pru River at Amantin and also on the River Pru itself at Prang. *G. morsitans* and *G. tachinoides* were also found at Prang in the more open country. *Haemaphysalis leachi* was common on the cattle at Jatto's Zonga, and this species, along with *Boophilus decoloratus*, was taken from my horse at Prang. Doubtless these were obtained from the dry grass in the stable.

Prang is on the boundary between Ashanti and the Northern Territories. From this town to Yeji the road formerly followed the Pru River, but as the greater part of it was under water in the wet season a new and more direct road has been made *via* Kaperleum. On this road *G. morsitans* is extremely abundant, and the only other blood-sucking insect seen was *Tabanus gratus*, which is also a dry country form. Water is very scarce on this road, and for this reason the Hausas prefer to herd their cattle and donkeys by the old road in the dry season. Nevertheless *G. morsitans* is abundant and this was especially marked near a small water-pool, the numbers diminishing at a distance from the water. Between Kaperleum and Yeji the same species was encountered. At Yeji game is fairly plentiful; buffalo, hartebeeste, waterbuck, bushbuck, cob, duiker and wart-hog are all found in the angle formed by the Rivers Volta and Pru. In all the country round Yeji *G. morsitans* is abundant, while *G. palpalis* and *G. tachinoides* are to be found on the River Volta. Ticks, *Amblyomma splendidum*, were found on a buffalo.

Yeji is the headquarters of a District Commissioner, and one of the largest ferries on the Volta River; it is on the main north road from Coomassie. In January 1913, over 8,100 natives crossed by canoe at this ferry and in the same month 7,000 animals were transported across. In 1912, the numbers were: natives over 50,000, animals 23,000. These cattle sometimes remain herded together for nearly a whole day both before and after swimming the river, and are consequently very liable to infection with trypanosomiasis owing to the great prevalence of tsetse.

This ferry is a good source of revenue to the Government, and part of this might with advantage be devoted to extensive clearing on both banks. The Commissioner stationed there during my visit informed me that this could be done at an annual outlay of £25. The only mosquito seen at Yeji was *Mansonioides uniformis*.

From Yeji to Makongo the road crosses two large swamps—backwaters of the Volta. *Mansonioides uniformis* is everywhere abundant round these swamps, and also at Makongo. At the latter place *Glossina palpalis*, *G. tachinoides* and *G. morsitans* were all common; the first two at the Makongo River and the last-named at some distance from the river. *Tabanus sticticollis* was also caught at Makongo. The same species of game as those given for Yeji are said to abound in this region. The following species of ticks were obtained at Makongo:—*Boophilus decoloratus*, *B. australis*, *Haemaphysalis leachi* and *Rhipicephalus sanguineus*.

After Makongo the country is still more open and there are fewer trees. In the vicinity of the water-courses *G. palpalis* and *G. tachinoides* were found near Maliki, while almost everywhere between Makongo and Salaga *G. morsitans* occurs.

Salaga is a very large town situated on the ridge which forms the watershed of the Volta and Daka. It is the headquarters of a District Commissioner and a Medical Officer. Water is exceedingly scarce and the water supply, both European and native, is from wells. There are over 800 of these wells or pits in the native town. The surrounding country is very bare, and there is hardly a shrub large enough to merit the name of a tree. The only blood-sucking flies seen here were *Tabanus subangustus* and *Hippobosca maculata*, but *Haematopota beringeri* has also been recorded from this area, and *Culicoides grahami* and *Phlebotomus antennatus* are said to be very troublesome at certain times of the year.

From Salaga to Dogankade the vegetation becomes slightly thicker; it is an extremely dry region and the nearest water at the time of my visit, 21st February 1913, was the River Daka, a tributary of the Volta, nearly two miles away. At this river *G. tachinoides* was found along with *Tabanus gratus*. *T. subangustus* was found in the town itself flying round the lamp at night.

From Dogankade to Turu the country is level; grass is everywhere abundant; the vegetation is scanty; there is no shade and no water on the road. The water supply for the town is several miles away. Between Turu and Palbusi the country is similar, and several dry water-courses were crossed. At the water supply, not far from the town, the following blood-sucking insects were captured:—*Glossina morsitans*, *Tabanus sticticollis*, *T. gratus*, *T. taeniola*, *T. biguttatus* var. *croceus* and *T. laverani*. From a horse several specimens of *Boophilus decoloratus* were taken.

North of Palbusi is the Cherebo River which becomes dry in January or February. The country is open as before and, if anything, more dried up. The following blood-sucking insects were caught at Palbe:—*Glossina morsitans*, *Stomoxys calcitrans*, *Tabanus gratus*, *T. taeniola*, *T. sticticollis* and *T. biguttatus* var. *croceus*.

From Palbe to Yamalga the country is still more open, and water and food are very scarce. The only blood-sucking fly seen in this region was *Tabanas gratus*, near the water supply at Palbe. Between Yamalga and Tamale the vegetation is similar to that described above.

(5.) **Tamale to Bawku.**

Tamale is the capital of the Northern Territories and the headquarters of the Chief Commissioner, the Provincial Medical Officer, and the Commandant of the Northern Territories' Constabulary. A large ginnery belonging to the British Cotton-Growing Association is also situated there. The European reserve is extensive, well-cleared, well-laid out and kept in splendid order. Blood-sucking flies are conspicuous by their absence, so much so, that in the dry season many Europeans dispense with a mosquito net. Horses seem to thrive well in this station. Every European keeps at least one pony, and there is a large well-filled stable in connection with the mounted constabulary. Deaths are very rare, and when such take place the infection can generally be traced to a time when a proclaimed region was traversed.

The native town is also well-kept and clean, but in the wet season mosquitos are not uncommon. The following species have from time to time been obtained there:—*Anopheles costalis*, *Culex tigripes* var. *fuscus*, *C. duttoni*, *C. univittatus*, *C. decens*, *Culiciomyia nebulosa*, *Ochlerotatus nigeriensis*, *Stegomyia fasciata* and

Stegomyia sugens. The only other blood-sucking fly so far recorded from Tamale is *Stomoxys calcitrans*, that is, in addition to the ubiquitous *Hippobosca maculata* which always accompanies cattle.

The main road from Tamale to Gambaga is *via* Savelugu, but at this point I made a detour to examine the tsetse-belt at Zantana, and rejoined the main road at Diari. From Tamale to Kombungu there is a well-cleared road through open country. No blood-sucking flies were seen on this trek. After Kombungu the native bush track had to be followed. The town is situated about 5 miles from the river Volta, which was extremely low at the time of my visit. The river banks are clad for the most part with heavy dense vegetation, and there *Glossina palpalis* was found. In the less sheltered places *G. tachinoides* was abundant, while in the open country *G. morsitans* was everywhere to be seen. Other blood-sucking insects seen in this region were *Tabanus pertinens*, *T. gratus*, *T. sticticollis*, *T. taeniola* and *Stomoxys calcitrans*.

The River Volta had to be crossed before Zantana was reached. In this part the country surrounding the river is very reminiscent of Northern Nigeria. For a considerable distance on either side of the river there is a dense "kurimi," while beyond that there occurs an extensive "fadama," swampy during the rains, but baked dry and hard in the dry season. *Glossina tachinoides* was caught near the river. Zantana is on one of the main trek routes between Coomassie and the north (*e.g.*, Navaro) and has a very bad reputation for horses.

Game is abundant all over this region, hartebeeste, roan antelope and wart-hog being the most common forms (hyaenas also abound), and wherever there was game there *Glossina morsitans* was found. On one occasion when traversing this region no tsetse were seen for hours, when suddenly we were surrounded by *G. morsitans*. They became a perfect nuisance and within a quarter of a mile of our first encountering them we came across a herd of roan antelope. On two other occasions in the Northern Territories I had the same experience, and am inclined to conclude that these tsetse were following the herds, in one case hartebeeste, and in the other cob ; the flies were caught fully two miles from water.

On the first occasion when I shot a roan antelope several *G. morsitans* and *Tabanus pertinens* collected round the buck and sucked up the blood oozing from the wound. On this animal were numbers of *Hyalomma aegyptium* and *Boophilus decoloratus*. From a wart-hog at the same place I obtained *Rhipicephalus simus*, and from a hartebeeste, *Amblyomma variegatum*.

Blood-sucking flies from Zantana include *G. tachinoides*, *G. palpalis*, *G. morsitans*, *Stomoxys calcitrans*, *Tabanus gratus*, *T. par*, *T. taeniola*, *T. pertinens*, and *T. sticticollis*.

The River Volta was again crossed between Tibungu and Singa, and there *G. tachinoides* was caught. The banks at this part had little or no thick vegetation, but more high grass. At the latter town *Tabanus gratus*, *T. pertinens*, *T. laverani* and *T. biguttatus* var. *croceus* occur, along with *G. tachinoides*. Game, including hartebeeste, water-buck and cob, were seen on the open grassy plains around Singa.

Between Singa and Sugu the Volta has again to be crossed, and the banks are covered with dense bush. The whole of the surrounding country must be very swampy in the rains; in March it was baked dry and very hard. *G. tachinoides*

was the only species of tsetse seen there, along with *Tabanus taeniola* and *T. pertinens*.

From Sugu I travelled to Diari which is on the main Tamale-Gambaga road. Here *G. tachinoides* was found, and on the grass I obtained a nymph of *Argas vespertilionis*. This is rather an unusual record, as the ARGASIDAE are not well represented in West Africa. Between Diari and Disiga no blood-sucking flies were seen, and water is practically non-existent in the dry season.

The country between Disiga and Nasia is extremely open and swampy in places during the rains. The River Kwarra has to be crossed about a mile from Nasia; there *G. tachinoides* and *Tabanus gratus* were caught. Game is abundant around Nasia, and although *Glossina tachinoides* is extremely common near the River Kwarra, no *G. morsitans* were seen in the vicinity. Other blood-sucking flies caught were *Stomoxys calcitrans, Tabanus gratus* and *T. sticticollis; Auchmeromyia luteola* was also found in the native town. At Boiyeni, about 20 miles further north, both *G. palpalis* and *G. tachinoides* were caught, along with *Tabanus laverani*. This record of *G. palpalis* is rather anomalous.

Between Boiyeni and Gambaga no blood-sucking flies were seen. Gambaga was the old headquarters of the Northern Territories before they were removed to Tamale. It is a well laid out and well kept town. The water supply is excellent, and consists of several springs in a valley. The only blood-sucking insect recorded from this town is *Tabanus biguttatus* var. *croceus*. Between Gambaga and Zongoire a very steep escarpment has to be descended, and in the depression thus formed lies the White Volta River. Near this river the following insects were caught:—*G. tachinoides, Tabanus gratus, T. pertinens, T. biguttatus* var. *croceus* and *Haematopota decora*. The White Volta River is again crossed after Zongoire and here *G. tachinoides* was obtained. At Kugiri the only blood-sucking fly seen was *T. pertinens*.

Between Kugiri and Binduri the country is almost pure savannah; at the latter town *G. tachinoides, T. gratus* and *T. pertinens* were captured. From Binduri to Bawku the vegetation is very scanty, and a number of bare volcanic hills rise abruptly from the general plain level. No blood-sucking insects were seen in this region.

(6.) Bawku to Lorha.

Bawku is the headquarters of a District Commissioner. The country around is extremely bare. The only blood-sucking insect seen was *Anopheles costalis*—in fact this was the first mosquito seen for over six weeks.

The journey from Bawku, which is at the extreme north-east corner of the Northern Territories, to Lorha in the north-west corner never departs far from the northern frontier. Between Bawku and Gogo the White Volta River is crossed not far from where it enters the Gold Coast from French territory. In April, this river consists of a few isolated pools in a sandy bed, with high banks covered with low vegetation. *Tabanus pertinens* and *T. gratus* were the only blood-sucking insects seen there. From Gogo to Lili the country consists of low undulating hills; in the valleys on this road two small streams were crossed, but vegetation on the banks was almost absent, and no blood-sucking flies were seen. Between Lili and Nangudi the Red Volta River, which joins the White Volta some distance south of this, was crossed. The vegetation on the banks was low and sparse—typical pure savannah country. At Nangudi *Anopheles costalis* was caught. From Nangudi to Zuaragu

the country is hilly and extremely open, and there is no water on the road. At Zuaragu is stationed a company of the West African Frontier Force; there is no indigenous native town. *Anopheles costalis* was the only blood-sucking insect seen.

From Zuaragu to Navaro the country is very open and thickly populated; the town of Navaro is scattered over several miles. Here is stationed a Provincial Commissioner. *Tabanus biguttatus* is the only insect recorded from this region. Between Navaro and Nakon the country is undulating and almost devoid of vegetation. Near Nakon the Sissili River, a tributary of the White Volta, has to be crossed, and there *Glossina tachinoides*, *Tabanus pertinens*, *T. gratus* and *T. taeniola* were captured. Game is said to be plentiful all along this river.

From Nakon to Batiasan the country is undulating, and there are numerous bare rocky mountains in the vicinity. Game, including elephant, hartebeeste and duiker, is abundant, and there the following blood-sucking insects were taken:—*Glossina morsitans*, *Tabanus gratus*, *T. pertinens*, *T. taeniola* and *T. ditaeniatus*. No species of blood-sucking fly was seen between Batiasan and Tumu. Game is also plentiful at Tumu, and there *G. tachinoides*, *G. morsitans*, *Tabanus gratus*, *T. biguttatus* var. *croceus* and *Anopheles costalis* were caught. *G. tachinoides* were found near the pools left by a falling stream, and *G. morsitans* in the more open country. From the nasal fossae of a hartebeeste shot there several large "bots" were taken.

Between Tumu and Lorha the country is undulating and very open, and not a single blood-sucking insect was seen in a trek of over 72 miles. About 12 miles north of Lorha is a small village, Penyabi, not far from the River Volta, which in this part forms the boundary between French Upper Senegal and the Northern Territories of the Gold Coast. Hippopotami occur in this part of the river, which is deep and slow-flowing. In the surrounding country there is game of various kinds, including roan antelope, cob, reedbuck, oribi and wart-hog. Near the banks of the river *Glossina palpalis* and *G. tachinoides* were found, and towards Penyabi, *G. morsitans* was far from rare. Other blood-sucking insects found in this region include *Tabanus gratus*, *T. taeniola* and *T. ditaeniatus*. From a wart-hog shot at Penyabi, *Hyalomma aegyptium* and *Rhipicephalus simus* were obtained. On the Volta River, near Lorha, *G. palpalis* was also captured, and it is more than probable that this species occurs all along the river in this region.

Lorha is the headquarters of a District Commissioner and a Medical Officer, and has the unenviable reputation of being one of the worst places for Guinea-worm in the Gold Coast. The constabulary suffer very much from this disease, and hardly ever is the hospital without one or more cases. Four, five and six Guinea-worms in one individual are not uncommon, and as many as seventeen have been found.

(7.) **Lorha to Kintampo.**

This road runs practically due south, parallel to the Anglo-French frontier. From Lorha to Nadawle the country is very open and park-like, and no blood-sucking insects were seen during this trek. At Nadawle, however, which is not very far from the River Volta, both *Glossina palpalis* and *G. tachinoides* occur. Near the town of Wa, *Tabanus taeniola* was caught, and the only other record from this region is *Chrysops longicornis*. Dr. Watt, who was stationed at Wa during my visit, informed me that he once caught two specimens of *Glossina longipalpis*, but tsetse are extremely rare in this region. Wa has also a bad reputation for Guinea-worm.

South of Wa, the country is more thickly clothed with bush. Near Tanina, *G. tachinoides*, *T. taeniola* and *T. gratus* were caught at a pool on the road. Between Tanina and Kulmasa, the vegetation becomes still more dense, and the following two species were obtained:—*T. taeniola* and *T. biguttatus* var. *croceus*. Cattle *en route* for Kintampo and Coomassie are everywhere to be seen on this road.

Between Kulmasa and Tuma, both *G. tachinoides* and *G. morsitans* were caught, and, in addition to these, *Tabanus taeniola* and *T. gratus*. Near Sawla, *Glossina morsitans* was plentiful, along with *T. biguttatus* var. *croceus*. In the rest-house at this town I also caught *Anopheles costalis* and *Stegomyia fasciata*. Game is not uncommon in this region, and from one duiker shot there I obtained a new species of *Echestypus*. Hartebeeste, cob, roan antelope and wart-hog are also found in this vicinity. At Mankuma *G. morsitans* was caught, and here also game is fairly plentiful. *Rhipicephalus simus* was found on a reedbuck shot near this town.

Bole is the headquarters of a District Commissioner and a Medical Officer. A very able and instructive paper on the mosquitos of Bole, their breeding habitats and habits by Dr. A. Ingram has appeared in this Bulletin,* and I recommend it for perusal to anyone interested in this subject. The following is a list of the species found in and around the station:—*Anopheles mauritianus*, *A. squamosus*, *A. rufipes*, *A. watsoni*, *A. funestus*, *A. costalis*, *Stegomyia fasciata*, *S. sugens*, *Ochlerotatus nigeriensis*, *Aëdomyia castasticta*, *Mansonioides uniformis*, *Culex quasigelidus*, *C. ager* var. *ethiopicus*, *C. duttoni*, *C. annulioris*, *C. univittatus*, *C. invidiosus*, *Mimomyia hispida*, *M. plumosa*, *M. splendens*, *Ingramia malfeyti*, and *Uranotaenia balfouri*. A sand-fly, *Ceratopogon incomptifeminibus*, also occurs there.

It is interesting to note that recently two cases of yellow fever in Europeans have occurred at Bole.

From Bole I visited a village called Wandara not far from the Volta. Game is abundant in this locality and the following blood-sucking insects were caught:—*Glossina tachinoides*, *G. morsitans*, and *Tabanus pertinens*. *Amblyomma variegatum* was found on the grass, and several specimens of *Haemaphysalis aciculifer* were obtained from a reedbuck. This species was recently described by Warburton from *Cobus thomasi*, shot in Uganda. A large herd of cattle was kept at Wandara and they all seemed to be in a perfect condition.

A road runs from Bole to Tamale, *via* Larabanga, Busunu and Daboya, and game is said to occur all over this region. A few records of *Glossina* from this part have been included on the map.

The country from Bole to Kintampo is covered for the most part with dense medium-sized trees, and game is said to occur throughout it. At Suripe *G. morsitans*, *Tabanus taeniola* and *T. biguttatus* var. *croceus* were caught; while at Sakpa *G. palpalis*, *G. tachinoides* and *G. morsitans* occur. Between Sakpa and Malawe *G. tachinoides* and *G. morsitans* were very troublesome all along the road; in fact, I had not seen so many at one time since my visit to the Zantana belt. They were frequent visitors to the rest-house, and *Haematopota bullatifrons* was also caught there.

Between Malawe and Wasipe *G. tachinoides* and *G. morsitans* were also plentiful, but no *G. tachinoides* were caught between Wasipe and Banda N'Kwanta. At the

*Bull. Ent. Res. iii, pp. 73-78 (1913).

latter place *G. morsitans*, *Tabanus taeniola* and *T. ruficrus* were found. From a duiker (red-flanked) a new species of *Echestypus* was taken. At Bandewa where the country is moderately open, but with a fair amount of low bush, the following species of blood-sucking insects were caught :—*Glossina palpalis*, *G. tachinoides*, *G. morsitans*, *Tabanus gratus*, *T. taeniola*, *T. par*, *T. ditaeniatus*, two new species of this genus, and *Culiciomyia nebulosa; Echestypus* sp., and *Rhipicephalus simus* were obtained from an oribi shot at Bandewa.

At Buere the River Volta is again crossed; this is the boundary between the Northern Territories and Ashanti, and also the southern limit in this region of *G. morsitans* and *G. tachinoides*, with the exception of Kintampo. At and near the Volta River at Buere the following blood-sucking insects were caught :—*G. tachinoides*, *G. morsitans*, *G. palpalis*, *G. longipalpis*, *Tabanus taeniola*, *T.* sp. near *congoiensis*, and *Haematopota* sp. near *noxialis*. At Bwe Camp, some distance up the River Volta, *G. palpalis*, *G. tachinoides*, *G. morsitans* and the rare *G. medicorum* were caught. Between Buere and Kintampo *G. palpalis*, *G. tachinoides*, *G. longipalpis*, *G. morsitans*, *Tabanus par* and *T. taeniola* were caught. It is highly probable, however, that the *G. tachinoides* and *G. morsitans* were sporadic examples which followed the natives and cattle across the river.

Kintampo is the headquarters of a Provincial Commissioner and a Medical Officer. One company of the West African Frontier Force is also stationed there. At this town five species of *Glossina* have been captured, viz.: *G. palpalis*, *G. tachinoides*, *G. pallicera*, *G. morsitans* and *G. longipalpis*. Recent extensive clearing along the river banks has caused an enormous reduction in the numbers of these insects, and Dr. Ingram, the Medical Officer stationed there during my visit, was strongly advocating further clearing. In this work he was warmly supported by Capt. Breckenridge, the Provincial Commissioner. The water supply at Kintampo is derived from a number of springs which have been well cleared. Recently a new native town has been built under the supervision of Mr. Ross, the Commissioner, and Dr. Ingram; it is a model of what can be done in the erection of sanitary native towns.

Other blood-sucking flies which have from time to time been caught at Kintampo include *Anopheles costalis*, *A. rhodesiensis*, *Stegomyia fasciata*, *Stomoxys calcitrans*, *Hippocentrum versicolor*, *Haematopota gracilis*, *Tabanus subangustus*, and *T. taeniola*

(8.) **Kintampo to Coomassie (via Sunyani).**

This road passes partly through savannah forest and partly through monsoon forest (see Map). Between Kintampo and Nyine *Glossina longipalpis* was the only blood-sucking insect seen, but towards Wenchi, in adddition to this species, *G. fusca* and *G. palpalis* were caught.

Wenchi is a recently opened station, and is now the headquarters of a District Commissioner. In this area *G. palpalis*, *G. pallicera*, *G. fusca* and *G. longipalpis* are common, while *Tabanus kingsleyi* and *Hippocentrum versicolor* were also caught. Near Chirah about 14 miles from Wenchi *G. palpalis*, *G. fusca*, *Hippocentrum versicolor*, *Haematopota gracilis* and *H. tenuicrus* were obtained.

Sunyani is a Provincial Commissioner's station, and, through the untiring efforts of Mr. T. E. Fell and Dr. W. M. Wade, the blood-sucking insect fauna of the surrounding district is fairly well known, as may be gathered from the map. The

following have been found in and around Sunyani:—*Glossina palpalis*, *G. caliginea*, *G. pallicera*, *G. nigrofusca*, *G. fusca*, *Rhinomyza stimulans*, *Stomoxys brunnipes*, *Tabanus kingsleyi*, *T. ruficrus*, *T. ianthinus*, *T. albipalpus*, *Hippocentrum trimaculatum*, *H. versicolor*, *Haematopota* sp. near *cordigera*, *Stegomyia fasciata*, *Culiciomyia nebulosa*, *Culex tigripes* var. *fuscus*, *Ochlerotatus cumminsi*, *Eretmopodites chrysogaster* and *Anopheles costalis*. This list may be taken as indicative of the insect fauna of this region, while the detailed records of the various species of *Glossina* are shown on the map. The forest is very dense and almost impenetrable all over this district.

Between Sunyani and N'Kwanta *G. palpalis* and *G. fusca* were caught on the road, and at Nsuta *G. palpalis* and *T. besti* var. *arbucklei* were obtained. At the rest-house at the last-named place a species of *Simulium* not yet identified was extremely troublesome.

Shortly after leaving Nsuta the monsoon forest was entered, but this did not seem to affect the character of the blood-sucking insect fauna. Between Nsuta and Fufu the following were caught:—*G. palpalis*, *G. fusca*, *Tabanus ruficrus*, *T. kingsleyi*, *T. fasciatus*, *T. besti*, and *T. besti* var. *arbucklei*. The only blood-sucking insect seen between Fufu and Coomassie was *T. kingsleyi*.

(9.) Coomassie to Sekondi (by Railway).

This railroad runs from Sekondi to Coomassie, a distance of 168 miles. It enters Ashanti at Dunkwa, where it crosses the River Ofin; attains its maximum elevation near Akrokerri, 134¼ miles from Sekondi; and then descends gradually to Coomassie, which is 858 feet above sea-level. South of Dunkwa, that is, in the Colony proper, the railway runs through the region drained by the Ankrobra River.

The only town on the railway visited and examined by me was Obuasi. This town, the capital of Southern Ashanti, has an elevation of 750 feet above sea-level, and is situated where the railway passes through a narrow gap in the hills which form the watershed between the basins of the River Ofin, and the River Prah. The small streams to the north-west of the town drain into the River Ofin, while those to the south-west are tributaries of the River Prah. Obuasi is a very important gold-mining centre. No tsetse-belt occurs in the immediate vicinity of the town, but *Glossina palpalis* is occasionally seen there, doubtless brought in by the trains, and *G. tabaniformis* has also been caught. This species is extremely rare in all parts of British West Africa; with the exception of a few records in the Gold Coast it has been found elsewhere only in Southern Nigeria.

Wood is used both for props and as fuel for the mines, and very extensive felling of timber has, therefore, been made. This probably accounts for the absence of tsetse in the immediate vicinity, as the area is thus rendered unsuitable for breeding or shelter. Beyond this clearing, some three miles from the town, *G. palpalis* is to be found.

According to Dr. W. M. Graham, who carried on prolonged entomological investigations in this region, *G. palpalis* occurs at the following points on the railway:—Sekondi, 6 miles, 16½ miles, 44½ miles, 81 miles, 92 miles, 99½ miles, 101 miles, 103½ miles, 115 miles, 118, 119 and 120 miles, 124 miles, 126 miles, 127 and 128 miles, 137⅛ miles, 148½ miles, 156 miles, Coomassie. *Glossina fusca* was

found at the following points:—Sekondi, 101 miles, 127 miles, 138 miles and 148½ miles. Other blood-sucking insects found at Obuasi include:—*Stomoxys calcitrans*, *S. brunnipes*, *S, nigra*, *S. omega*, *S. inornata*, *Tabanus besti*, *T. secedens*, osus *T. marmor~~atus;~~* *Haematopota cordigera*, *Chrysops dimidiata* and *C. longicornis*.

Tabanus kingsleyi was caught at Dunkwa and a specimen of *G. pallicera* entered the carriage in which I was seated, at Mansu.

Sekondi is a very important seaport, on account of its being the railway terminus and the port of entry for the gold mines. *Glossina fusca* and *G. palpalis* both occur there; of the latter species I caught one specimen in the hospital laboratory while I was there. Mosquitos were very troublesome at the time of my visit (18th June). The following are the species caught:—*Culex invidiosus*, *C. rima*, *Ochlerotatus domesticus* and *O. irritans*. Other blood-sucking flies include *Tabanus par*, *T. ruficrus*, *T. secedens* and *T. socialis*.

Stegomyia fasciata is by no means uncommon, but of recent years an enormous reduction in their numbers has been made through improved methods of sanitation. There have been several outbreaks of yellow fever at this port.

(10.) Sekondi to Accra.

This journey was made overland by way of the coast in order to examine the various ports and villages otherwise difficult of access. The coast consists for the most part of low, sandy shore with high cliffs at intervals, and is beaten by a heavy surf which causes a dense mist for some distance inland. The vegetation at this part near the shore is mostly grass and low scrub, but further inland low savannah forest is predominant.

Between Sekondi and Shama *Glossina longipalpis* was found at several places, whilst at a small creek, about half-way, surrounded by mangrove swamp, *G. palpalis* was caught. The latter species was captured at Shama along with *Tabanus kingsleyi* and *T. secedens*. Shama is an ancient town situated at the mouth of the River Pra with a very old Portuguese fort. The main industry is fishing, and a large amount of fish is dried and smoked in clay ovens. These ovens, when out of use, generally retain water, and are a favourite breeding ground for mosquitos, which consequently are to be found in abundance. Another source of mosquitos is the large number of old canoes containing water in which the fishing nets are tanned. These generally contain innumerable larvae.

The River Pra has to be crossed by canoe between Shama and Elmina. This region is surrounded by mangrove swamp, and *G. palpalpis* abounds there; *G. longipalpis* and *G. fusca* were also found during this trek.

At Elmina is situated the oldest fort in West Africa; it was built by the Portuguese in the 14th century. A large number of troops were quartered there during the Ashanti Wars; the rate of mortality was very high, and according to some authorities the disease responsible for the deaths was yellow fever. The area around has been well cleared and is kept in good order, but the remarks made with regard to Shama apply equally well for the native town of Elmina. The only mosquito caught was *Stegomyia fasciata*, but both *G. longipalpis* and *G. fusca* were found in the vicinity.

Between Elmina and Cape Coast, a distance of nine miles, no blood-sucking flies were seen. Recently at this station a ridge about 2 miles away from the native

town was selected as a segregation area for European officials, and bungalows are being built there. This should improve the health of the officials at Cape Coast, because up till now the intermingling of European quarters and native shops and dwellings was a crying disgrace. Mosquitos are far from uncommon in Cape Coast, but sanitary measures are being stringently carried out, and the good effect of such work is already being felt, and is bound to be still more marked in the near future. The following species are not uncommon *Culex decens*, *Culiciomyia nebulosa*, *Ochlerotatus minutus*, *Mansonioides africanus*, *Stegomyia fasciata* and *S. sugens*. Yellow fever cannot be said to be stamped out in this town, but every endeavour is being made to secure this end.

Before the construction of the Sekondi-Coomassie Railway, Cape Coast was a much more important town than at present, inasmuch as the "Great Northern Road" to Coomassie started from this port. It was at Cape Coast that all the troops were landed during the Ashanti Wars, and it was by the above-mentioned road that they emerged on Coomassie. Until recently this road has been neglected, but trade and other considerations have rendered the reconstruction of it advisable, so that the following notes may not be out of place.

The Cape Coast-Coomassie road crosses the River Prah at Prahsu; at one place (Moinsi Hill), it attains an elevation of 1,200 feet, and then gradually descends to Coomassie, 858 feet above sea-level. The total length of the road is 120 miles. Running in a north-west direction the road enters Ashanti at Prahsu, and then gradually approaches the railway, which it crosses several times between Eduadin and Coomassie. The portion of the road within Ashanti runs through dense forest and crosses numerous streams, *e.g.*, the Fum, Jym, Dankrang, Adra, and their tributaries. In this region *G. palpalis*, *G. pallicera* and *G. fusca* have been found at various places. The available records are included on the map.

Between Cape Coast and Saltpond *G. longipalpis* occurs the whole way, but the only other blood-sucking insect found in this region was *T. ruficrus*. Much has recently been done at Saltpond in the way of improved sanitation, but the old canoes used for tanning nets are the chief source of trouble for the Medical Officer. From Saltpond to Tantum the road crosses the River Nakwa. *G. palpalis* were there found, and *G. longipalpis* is abundant in the region around Tantum. *G. longipalpis* is also common between Tantum and Winneba at those places where the road leaves the beach and enters the low scrub. These flies followed the carriers in several places to high-water mark. They are also sometimes found in the European bungalows in the town itself.

Mosquitos are troublesome in the town of Winneba, coming from a swamp behind the town, which is badly drained, and also from the casks and old canoes used for tanning nets. These swarmed with mosquito larvae, mostly Culicine, but also Anopheline. Between Winneba and Feteh *G. longipalpis* was everywhere abundant in those regions where the road leaves the beach and enters the low bush. No blood-sucking flies were seen from Winneba to Accra.

Reviewing this journey from Sekondi to Accra one sees that the predominant species of tsetse is *G. longipalpis*; *G. palpalis* is found at the mouths of the rivers and *G. fusca* where the vegetation is dense. Fishing is the principal industry at all the towns and villages, and the casks, old canoes and other receptacles used for tanning nets are the principal factors in maintaining the scourge of mosquitos so

prevalent in this region. This is a point well worthy of the attention of the sanitary authorities.

IV. Records of Blood-Sucking Insects and other Arthropods from the Gold Coast.

The following list includes, so far as possible, all the species so far identified, but several more await identification and description. It will be seen from the list of Tabanidae that our knowledge of this group has advanced considerably since the publication of Austen's Monograph of the African Blood-sucking Flies in 1909, and doubtless further research will reveal several species not yet found in the regions examined. A noteworthy feature brought out in this list is the fact no fewer than ten different species of *Glossina* have been found in the Gold Coast. The Culicidae also present a rather formidable list. Our knowledge of the distribution of the various species tabulated here is, however, very scanty, and it would be premature to discuss this aspect of the subject, except in a very general way. The various records so far known are referred to briefly in the Narrative, and it is to be hoped that those interested in this subject will collect every available species from as many localities as possible to enable a general idea of the distribution of each to be arrived at.

Order DIPTERA.

Family Culicidae.

Aedomyia catasticta, Knab.
Anopheles costalis, Lw.
" *funestus*, Giles.
" *mauritianus*, Grp.
" " var. *paludis*, Theo.
" *pharoensis*, Theo.
" *squamosus*, Theo.
" *rhodesiensis*, Theo.
" *rufipes*, Gough.
Culex ager, Giles var. *ethiopicus*, Edw.
" *annulioris*, Theo.
" *argenteopunctatus*, Ventr.
" *consimilis*, Newst.
" *decens*, Theo.
" *duttoni*, Theo.
" *fatigans*, Wied.
" *grahami*, Theo.
" *guiarti*, Blanch.
" *invidiosus*, Theo.
" *ornatothoracis*, Theo.
" *pruina*, Theo.
" *quasigelidus*, Theo.
" *rima*, Theo.
" *thalassius*, Theo.
" *tigripes*, Grp. var. *fucus*, Theo.
" *univittatus*, Theo.
Culiciomyia nebulosa, Theo.
Eretmopodites chrysogaster, Grah.
" *grahami*, Edw.
" *inornatus*, Newst.
" *leucopus*, Grah.
" *oedipodius*, Grah.
Eumelanomyia inconspicuosa, Theo.
Harpagomyia trichorostris, Theo.
Hodgesia cyptopus, Theo.
Ingramia malfeyti, Newst.
Mansonioides africanus. Theo.
" *uniformis*, Theo.
Mimomyia hispida, Theo.
" *plumosa*, Theo.
" *splendens*, Theo.
" *mimomyiaformis*, Newst.
Mucidus mucidus, Karsch.
" *scatophagoides*, Theo.
Ochlerotatus abnormalis, Theo.
" *albocephalus*, Theo.
" *cumminsi*, Theo.
" *domesticus*, Theo.
" *furcifer*, Edw.
" *irritans*, Theo.
" *minutus*, Theo.
" *nigeriensis*, Theo.
" *nigricephalus*, Theo.
" *punctothoracis*, Theo.
" *simulans*, Newst & Cart.
Stegomyia argenteoventralis, Theo.
" *apicoargentea*, Theo.
" *fasciata*, F.
" *simpsoni*, Theo.
" *sugens*, Wied.
Taeniorhynchus metallicus, Theo.
Toxorhynchites brevipalpis, Theo.
" *phytophagus*, Theo.
Uranotaenia balfouri, Theo.
" *ornata*, Theo.
" *mashonaensis*, Theo.
" *annulata*, Theo.
" *mayeri*, Edw.
" *bilineata*, Theo.
" *connali*, Edw.

Family CHIRONOMIDAE.

Culicoides grahami, Aust.
Ceratopogon incomptifeminibus, Aust.

Family SIMULIIDAE.

Simulium damnosum, Theo.

Family PSYCHODIDAE.

Phlebotomus antennatus, Newst.
Phlebotomus minutus, Rond. var. *africanus*, Newst.

Family TABANIDAE.

Chrysops dimidiata, Wulp.
,, *distinctipennis*, Aust.
,, *longicornis*, Macq.
Haematopota beringeri, Aust.
,, *bullatifrons*, Aust.
,, *cordigera*, Big.
,, sp. near *cordigera*.
,, *decora*, Walk.
,, *gracilis*, Aust.
,, *grahami*, Aust.
,, *hastata*, Aust.
,, sp. near *noxialis*, Aust.
,, *semiclara*, Aust.
,, *tenuicrus*, Aust.
,, *torquens*, Aust.
Hippocentrum trimaculatum, Newst.
,, *versicolor*, Aust.
Rhinomyza stimulans, Aust.
Subpangonia grahami, Aust.
Tabanus albipalpus, Walk.
,, *besti*, Surc.
,, *besti*, var. *arbucklei*, Aust.
,, *biguttatus* Wied. var. *croceus*, Surc.
Tabanus combustus, Big.
,, sp. near *congoiensis*, Ric.
,, *ditaeniatus*, Macq.
,, *fasciatus*, F.
,, *gratus*, Lw.
,, *ianthinus*, Surc.
,, *kingsleyi*, Ric.
,, *laverani*, Surc.
,, *marmorosus*, Surc.
,, *obscurissimus*, Ric.
,, *par*, Walk.
,, *pertinens*, Aust.
,, *pluto*, Walk.
,, *secedens*, Walk.
,, *simpsoni*, Aust.
,, *socialis*, Walk.
,, *sticticollis*, Surc.
,, *subangustus*, Ric.
,, *taeniola*, P. de B.
,, *tenuipalpis*, Aust.
,, *thoracinus*, P. de B.
Thaumastocera akwa, Grünb.

Family MUSCIDAE.

Auchmeromyia, luteola, F.
Cordylobia anthropophaga, Grünb.
Glossina caliginea, Aust.
,, *fusca*, Walk.
,, *longipalpis*, Wied.
,, *medicorum*, Aust.
,, *morsitans*, Westw.
,, *nigrofusca*, Newst.
,, *pallicera*, Big.
Glossina palpalis, R. D.
,, *tabaniformis*, Westw.
,, *tachinoides*, Westw.
Lyperosia minuta, Bezzi.
Stomoxys brunnipes, Grünb.
,, *calcitrans*, L.
,, *inornata*, Grünb.
,, *nigra*, Macq.
,, *omega*, Newst.

Family HIPPOBOSCIDAE.

Hippobosca maculata, Leach
Echestypus sp.

Order RHYNCHOTA.

Family CLINOCORIDAE.

Clinocoris hemiptera, F.

Order SIPHONAPTERA.

Family PULICIDAE.

Ctenocephalus canis, Curtis.
,, *felis*, Bouché.
Xenopsylla cheopis, Roths.

Family SARCOPSYLLIDAE.

Dermatophilus penetrans, L.

Order ACARI.

Family ARGASIDAE.

Argas vespertilionis, Latr.

Family IXODIDAE.

Amblyomma splendidum, Giebel.
,, *variegatum*, F.
Boophilus australis, Fuller.
,, *decoloratus*, Koch.
Haemaphysalis aciculifer, Warb.
Haemaphysalis leachi, Aud.
Hyalomma aegyptium, L.
Rhipicephalus sanguineus, Latr.
,, *simus*, Koch.

V. Insect-Borne Diseases of Man and Other Animals.

(1.) **Malaria.**

This disease is still one which has to be reckoned with in the Gold Coast. In 1910, of the official population six were invalided with this disease and three died of it; of the non-official population, twelve were invalided and twelve died from malaria. In 1911, three officials and twenty-one non-officials were invalided with malaria; the deaths I have been unable to ascertain.

In the Medical and Sanitary Report for the Gold Coast for 1910, the following appears:—"The curve (seasonal prevalence) for malaria begins to rise slowly soon after the rains set in, and reaches its greatest height in August. There is then a fall and a second, but small, rise in October, followed by another fall. The prevalence of this disease is, of course, in direct proportion to the Anopheline rate. It does not begin to rise until some time after the commencement of the rains, because there has not yet been time for any great number of mosquitoes to be bred and become infected. During the heavy rains, moreover, stagnant pools suited to the habits of the Anophelines are less numerous and are constantly being flushed out by flood water, and it is therefore only when the rainfall is decreasing and these pools remain for longer periods that the great rise in the malarial rate takes place. The small secondary rise . . . is possibly due to the nearly equal rainfall from August to October, which would be sufficient to maintain many suitable pools at a fairly constant level."

This is very suggestive, and shows the time at which most effective control could be instituted in the way of draining and oiling.

Dr. J. M. O'Brien, when in charge of the Accra Laboratory in 1911, in investigating the malarial index of the school children of ages ranging from four to fifteen in Accra, found that about twenty per cent. of the children harboured parasites, mostly malignant tertian, a few quartan and rarely benign tertian. He states also that more than half had recently suffered from malaria.

(2.) **Yellow Fever.**

This insect-borne disease is still far from uncommon in West Africa. In the early part of 1910 ten cases of yellow fever, nine of which proved fatal, occurred amongst the European population in Sekondi. Three deaths are also known to have occurred amongst natives. In 1911 there were six cases of this disease in Europeans in Accra and Axim, all of which proved fatal. Cases have also occurred in Kwitta, Cape Coast and elsewhere along the coast, and quite recently two cases in Europeans occurred at Bole in the Northern Territories.

It will be seen from the narrative that *Stegomyia fasciata* is by no means limited in its distribution, although it is most common along the coast towns. When dealing above with Shama, Saltpond, Winniba, etc., I pointed out the main source of the mosquito supply, and one cannot advocate too strongly the adoption of some measure to mitigate the prevalence of this pest.

(3.) **Sleeping Sickness.**

The Gold Coast suffers more from sleeping sickness than any other British Colony in West Africa. The accompanying map shows the distribution of this disease, so far as can be definitely ascertained, but cases from widely diverse localities have been

treated at various centres (*vide infra*); the exact localities from which these came are not available, however, and so have not been included on the map.

Our knowledge of the distribution of sleeping sickness in the Gold Coast is based chiefly on the work of Drs. Kinghorn and Wade, and their reports should be consulted for further details.

In the Colonial Report for 1909 the following occurs: "Sleeping sickness proved more prevalent in Ashanti than in the Colony or the Northern Territories and, in the cases of Wenchi, Sunyani and Cheremankoma this disease almost assumed an epidemic form."

In the Report for 1910 the Principal Medical Officer says: "During the year fifty cases of sleeping sickness were treated in the different hospitals, and eleven deaths were recorded; the disease is more prevalent in Ashanti than in the Colony. The possibility of an outbreak of sleeping sickness in the Gold Coast is now recognised, and efforts are being made to cope with the situation. Towards the end of the year 107 cases were under observation and treatment; their distribution was as follows: Accra 1, British Krachi 1, Coomassie 12, Kintampo 1, Sunyani 15, 70 cases from various Ashanti villages, Gambaga 1, Zuaragu 1, and 5 other cases from villages in the Northern Territories." The exact localities of these cases are not available for inclusion on the map.

In 1911 seventeen deaths from sleeping sickness were reported in Ashanti and one in the Northern Territories; in all 83 cases were known to exist, six in the Colony and 77 in Ashanti and the Northern Territories. In the Gonja district to the west of Salaga whole villages are reported to have been deserted by the natives on account of this disease.

During Dr. Kinghorn's tour in Ashanti in 1910 he examined 9,171 natives and found 92 cases of trypanosomiasis; this gives 1 per cent. of the population infected. In the same region in 1911 Dr. Wade found 32 new cases. In the north-west portion of Ashanti it is estimated that over 1·5 per cent. of the population suffer from this disease; while in Wenchi, a town about half-way between Sunyani and Kintampo, 14 cases were found in 1910, and nine deaths was recorded in that year; in 1911 eight new cases were found, and the proportion of sleeping sickness cases to the total population is estimated at 5 per cent.

Thus we see that although Ashanti is the chief focus of the disease, nevertheless it occurs all over the Gold Coast; it is also very prevalent both in German Togoland and in the French Ivory Coast. In the former colony a sleeping sickness camp has been inaugurated at Kluto, and the disease is said to be very common in Bonduku in the Ivory Coast; this town is not far from the frontier of Western Ashanti.

In a heavily forested country like Ashanti wholesale clearing around villages, at wells and ferries is a herculean task, and one which would entail heavy expenditure; but in the present state of our ignorance of the bionomics of the various species of tsetse it is the only prophylactic measure which can be effectively employed.

(4.) **Plague.**

A serious outbreak of this dread disease took place in the Gold Coast in 1908-9, but was effectually stamped out. No cases have been reported since 1910, and every means is being taken for the extermination of rats and other vermin which might harbour the transmitting insect, *Xenopsylla cheopis*.

(5.) Trypanosomiasis of Stock.

Very few cattle are bred in the Gold Coast; the great majority of those slaughtered in the Colony are brought from the Moshi country north of the Northern Territories; but there is a small breed of non-humped cattle bred in the Addah-Kwitta country, known as Addah cattle. Of the cattle brought down from the north and slaughtered in Coomassie for food about 80 per cent. harbour trypanosomes. In Accra during 1911 Dr. J. M. O'Brien found that 17 per cent. of the cattle had trypanosomes, and says "when there was opportunity to make enquiries concerning the animals from which the smears originated, it was always found that those with trypanosomiasis were taken from the humped cattle from the North." In 1912 a large number of Addah cattle were found to harbour trypanosomes, but Dr. Connal informs me that during 6½ months when he was stationed at Kwitta he found none in the cattle in that region. It would thus appear that trypanosomiasis of cattle is all too common in the Gold Coast.

Horses also suffer greatly from this disease, and with the exception of a very few places, are restricted to certain districts in the Northern Territories. According to Mr. Beal, the Veterinary Surgeon, *Trypanosoma dimorphon*, *T. pecaudi* and *T. cazalboui* are equally prevalent in horses, while only the two last-named are found in cattle; the first has also been found in dogs.

Two out of 83 sheep examined at Accra were found with trypanosomes similar to those in cattle.

Only one case of trypanosomiasis in a goat has been recorded, but no pig has been found to be infected.

(6.) Spirochaetosis.

Dr. J. M. O'Brien records two cases of spirochaete infection in sheep and one in a goat.

VI. The Distribution of the Genus Glossina.

In many respects the Gold Coast resembles Nigeria; the types of vegetation are the same, the distribution of the rainfall is similar, and the differences in the duration of the wet and dry seasons are closely paralleled. The colony of the Gold Coast may be compared with Southern Nigeria, except that in the latter the delta of the Niger has features peculiar to itself not found in the Gold Coast; Ashanti has its analogue in the northern part of Southern Nigeria and the southern part of Northern Nigeria; while the Northern Territories of the Gold Coast are comparable in every way with the northern portion of Northern Nigeria.

The same species of *Glossina*, ten in number, are found in both Colonies, and their distribution is limited by the same natural features in both. These species belong to all the four groups described by Austen in his "Handbook of the Tsetse-Flies." It must be remembered that the records at present available are far from exhaustive, but the following notes may serve to illustrate the general trend of the distribution of each species. The accompanying map will show this more graphically.

Palpalis Group.

Four species belonging to this group are found in the Gold Coast. By far the most widely distributed of these is *G. palpalis*, which is closely associated with all the river systems. In the Colony and Ashanti it is almost universally distributed,

but in the Northern Territories it diminishes in numbers and is found only in the vicinity of the White and Black Volta Rivers, where there is fringing forest and a relatively constant high humidity.

G. tachinoides is the predominant species of this group found in the Northern Territories. It is associated with open country, *i.e.*, thin savannah forest tending to pure savannah, a relatively low humidity and a prolonged dry season.

G. caliginea is found in the Gold Coast only in the heavily forested part of Western Ashanti. In Southern Nigeria it occurs along the coast region. Both of these areas are characterised by a relatively high humidity.

G. pallicera is also confined to the moist forest region of Western and Southern Ashanti. It is also found in Southern Nigeria at Benin City, where the type of vegetation and the nature of the climate and rainfall are similar.

Morsitans Group.

Two species of this group, namely, *G. longipalpis* and *G. morsitans*, occur in the Gold Coast. The former is found in the denser parts of the savannah forest, and so far has not been seen south or west of the line dividing the monsoon forest from the savannah, while it occurs along the coast in the savannah forest area. A glance at the map will make this most interesting distribution clear.

To the north of the savannah forest region it diminishes in numbers and gives place to *G. morsitans*, which, like *G. tachinoides*, is associated with open country, a low relative humidity, a prolonged dry season, and high temperatures.

Fusca Group.

Three species of this group are represented in the Gold Coast. *G. fusca* is the most common, and is found in the densely forested country where there is abundant shade, and a fairly equable perennial humidity.

G. nigrofusca and *G. tabaniformis* are much more rare, but are found in similar localities. The former has been recorded from the western part of Ashanti and north of Coomassie; the latter in Western Ashanti, in the rain forest in the West of the Colony and near Obuasi. The physical features which favour *G. fusca* seem also to be suitable for these two species.

Brevipalpis Group.

The only species of this group found in the Gold Coast is *G. medicorum*, of which two specimens were captured at Bwe Camp on the Volta River, three days from Kintampo, by Dr. C. W. S. Boggs. The species has also been taken on the road between Preniase and Bassa by Dr. A. Ingram, at Obuasi, by Mr. G. C. Dudgeon, and at Sekondi, by Dr. W. M. Graham.

I have already discussed in previous reports the main factors which influence the general distribution of the various species of *Glossina* and would, therefore, refer the reader to these; especially that on S. Nigeria.* The conclusions arrived at with regard to Nigeria are found to be equally applicable to the Gold Coast.

In the narrative (Chapter III) a few notes on the association of tsetse and game have been recorded, but it might be well to state here that from observations made in a small area during a short period, I am strongly inclined to think that there is a

* Bull. Ent. Res. iii, pp. 189–191 (1912).

closer connection between the prevalence of game and *G. morsitans* than with any other species. This is a subject, however, which demands more concentrated investigation in a limited area, and in no part of West Africa could this be more effectively carried out than in the Northern Territories of the Gold Coast, where game is, so far as is known, restricted in its distribution; where densely populated and uninhabited areas occur; where cattle seem to thrive in some parts and not in others; and where *G. palpalis* and *G. tachinoides* exist side by side, the former predominating southwards and the latter northwards, the same holding good for *G. longipalpis* and *G. morsitans* respectively.

VII. Parasites of Game and other Mammals.

During my tour in the Gold Coast I made a systematic attempt to collect information as to the various parasites harboured both by domestic animals and game, but I shall confine myself here only to those which are directly connected with this work.

Blood-Parasites.

Game.—Blood smears taken from eleven different kinds of game gave negative results.

Horses.—According to Mr. Beal, the Veterinary Surgeon, *Trypanosoma dimorphon*, *T. pecaudi* and *T. cazalboui* are equally prevalent in horses.

Cattle.—*Trypanosoma pecaudi* and *T. cazalboui* have been found in cattle.

Sheep.—The trypanosomes found in sheep are the same as those in cattle.

Dogs.—Only *Trypanosoma dimorphon* has so far been found in dogs.

Internal Parasites.

Apart from "worms," only "bots" are found internally. Bots taken from the stomach of horses, which had been post-mortemed by Mr. Beal, were identified at Yaba as *Gastrophilus equi* and others found since that time he is inclined to believe are *Oestrus pecorum*. From the nasal sinuses of a haartebeeste shot by the author at Tumu several bots were taken; these have not yet been identified.

External parasites.

The following arthropod parasites were taken from game shot by the author:—*Amblyomma splendidum* from buffalo; *Hyalomma aegyptium* and *Boophilus decoloratus* from roan antelope; *Amblyomma variegatum* from haartebeeste; *Rhipicephalus simus* and *Hyalomma aegyptium* from wart-hog; *Haemaphysalis aciculifer* and *Rhipicephalus simus* from reed-buck; *Rhipicephalus simus* from oribi; and *Echestypus* sp. from oribi and two species of duiker.

In conclusion, I wish to take this opportunity of thanking His Excellency Sir Hugh Clifford, K.C.M.G., Governor of the Gold Coast, during part of whose tenure of office this investigation was carried out. The greater part of the organisation, however, fell to the Acting-Governor, Major Bryan, C.M.G., and to him and to Dr. F. G. Hopkins, the Principal Medical Officer, I should like to tender my sincere thanks for much sound advice, for many personal kindnesses, and for the expeditious manner in which everything was done to promote interest and facilitate the investigation. To Dr. Tweedy, the Deputy Principal Medical Officer, Dr. Montgomery, the Provincial Medical Officer at Coomassie, and Captain Armitage, C.M.G., D.S.O., Chief

Commissioner of the Northern Territories, my best thanks are also due for much official help and kind hospitality. To Mr. Fuller, C.M.G., Chief Commissioner of Ashanti, Dr. E. V. Graham, Dr. A. Ingram, and the many other officers, both political and medical, with whom my work brought me in contact, and through whose advice and help delay and loss of time were reduced to a minimum, I must express my indebtedness for the assistance everywhere given, and the whole-hearted sympathy evinced. To those who advanced our knowledge of definite areas by collecting specimens the thanks of the Committee are also due; such collections have been acknowledged from time to time in this Bulletin, and lists of identifications have been sent both to the collectors and to the Principal Medical Officer.

FIG. 1. Road between Accra and Christianborg showing roadside pools where mosquitos breed.

FIG. 2. View near Accra showing the nature of the vegetation.

FIG. 1. View on road at Accra showing the effect of the sea breeze.

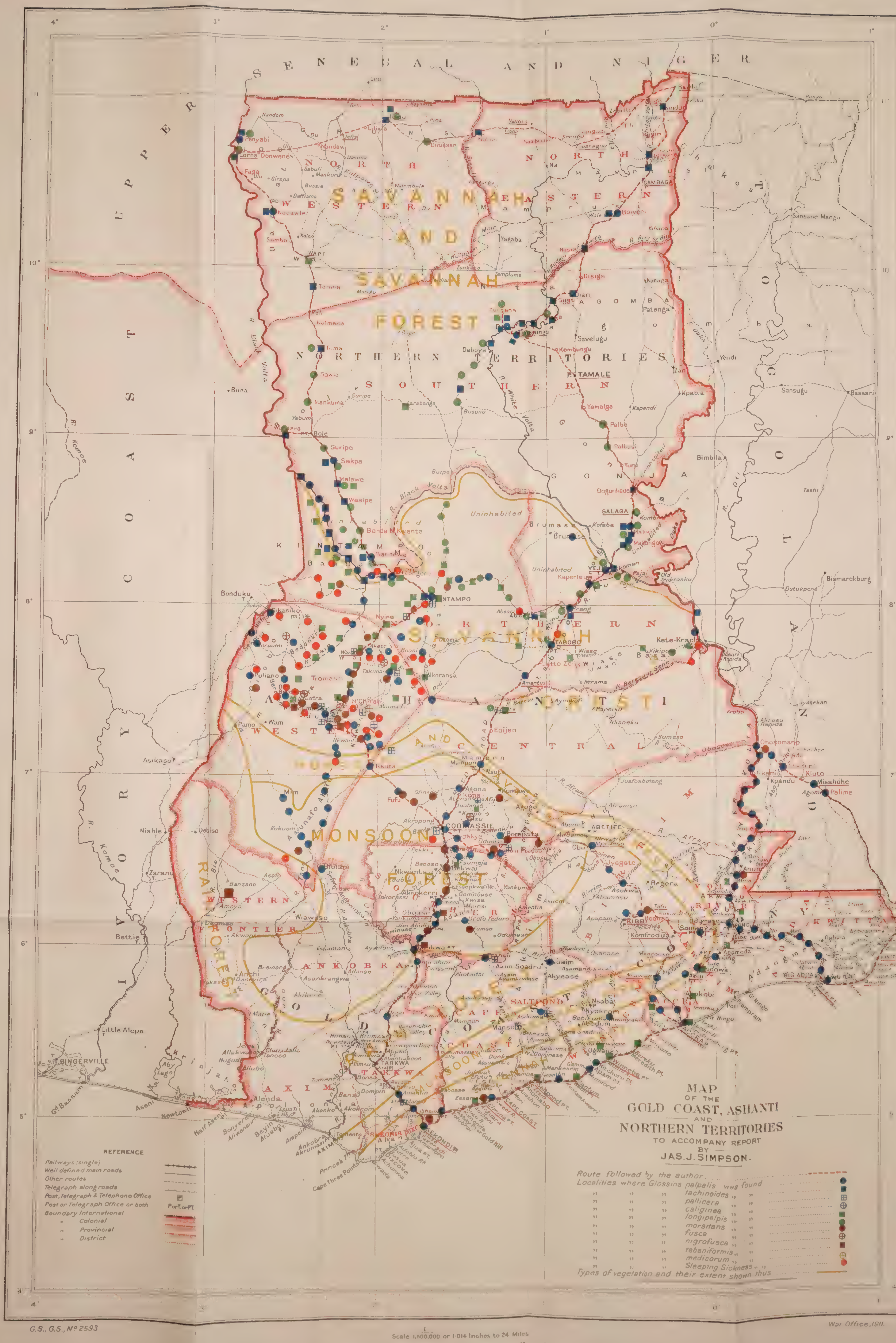
FIG. 2. View at Accra to show the nature of the surrounding country.

Fig. 1. View of Nsawam showing the clearing in the forest.

Fig. 2. View in Ashanti to show the nature of the vegetation on the banks of the streams.

FIG. 1. View of the dam at the Weshiang Waterworks—a breeding place of *Mansonioides uniformis*.

FIG. 2. General view of the town of Cape Coast.



MAP OF THE GOLD COAST, ASHANTI AND NORTHERN TERRITORIES
TO ACCOMPANY REPORT
BY
JAS. J. SIMPSON.
Route followed by the author
Localities where Glossina palpalis was found
" " " tachinoides " "
" " " pallicera " "
" " " caliginea " "
" " " longipalpis " "
" " " morsitans " "
" " " fusca " "
" " " nigrofusca " "
" " " tabaniformis " "
" " " medicorum " "
" " " Sleeping Sickness " "
Types of vegetation and their extent shown thus
REFERENCE
Railways (single)
Well defined main roads
Other routes
Telegraph along roads
Post, Telegraph & Telephone Office
Post or Telegraph Office or both
Boundary International
" Colonial
" Provincial
" District
SENEGAL AND NIGER
UPPER
IVORY COAST
TOGO
SAVANNAH AND SAVANNAH FOREST
NORTHERN TERRITORIES
MONSOON FOREST
RAIN FOREST
ASHANTI
COOMASSIE
ACCRA
CAPE COAST
SEKONDI
TAMALE
SALAGA
KINTAMPO
G.S., G.S., Nº 2593
War Office, 1911.
Scale 1/1,500,000 or 1·014 Inches to 24 Miles

SHEEP-MAGGOT FLIES IN AUSTRALIA.

By Walter W. Froggatt, F.L.S., etc.

Government Entomologist, New South Wales.

The most serious pests that at the present time are threatening the great wool and sheep industry of Australia, are the sheep-maggot flies (blow-flies belonging to the genus *Calliphora*). Until about ten years ago blown wool on living healthy sheep was unknown, sheep that were worried and torn by dogs were blown, and rams that damaged their heads fighting might have to be dressed and cleaned of maggots, but the bush blow-flies had not until about that date acquired or developed the habit of depositing eggs or living maggots in the soiled or damp fleece of the ordinary station paddock sheep.

They were first noticed among the stud sheep where the fleece was fine, close, and heavy with yoke; then they found the lambing ewes, attacked the lambs after marking, then any close-woolled dirty wether, and finally infested the rams; so that at the present time we find all classes and sexes fly-blown at some time of the year. The damage and expense caused by the presence of these maggots is three-fold. They usually blow the wool round the tail or rump (some of the best of the fleece); they cause the death of many sheep and lambs; and they are responsible for a great amount of very objectionable and disgusting work, which keeps a number of men doing nothing but crutching and dressing sheep all the year round, entailing a large extra expenditure of time and money on every sheep station. In the first instance, when blown sheep were observed and flies were bred from the maggots, they were almost always the two large yellow species common in both town and country: *Calliphora villosa*, the larger golden-yellow-bodied fly; or the somewhat smaller *Calliphora oceaniae*, distinguished by the bright blue patch on the sides of the abdomen. But in a very short time the metallic blue blow-fly, *Calliphora rufifacies*, acquired the habit and is now in the north and north-west parts of this State the chief cause of all the damaged wool. The larvae of the last-named species are darker and not so elongate as the smooth cylindrical maggots of the two former species; they are usually known among bushmen as "hairy maggots," on account of the fringe of fine fleshy filaments along the sides of the segments. All kinds of dips, dressings and patent mixtures have been tried by the sheep-owners (and numbers of new ones are being placed on the market) to dress the infested wool and inflamed skin, to kill the maggots in the wool, or to keep the flies away from the sheep; but nothing up to the present time has been discovered that will keep the flies from blowing wool for more than a few weeks, in spite of all that the makers claim for their mixtures. After travelling among the sheep stations for some time, I issued a report "The Sheep Maggot Fly, with notes on other common Flies," published in the *Agricultural Gazette of N. S. Wales*, January 1905, reprinted and widely distributed among the sheep-owners as a Miscellaneous Publication, No. 809. This was supplemented by a second report in 1910, entitled "Sheep Maggot in the West," in the same journal, afterwards reprinted as a Miscellaneous Publication. In 1913, the Cooper Laboratory for Economic Research published my prize essay "The Sheep Maggot-Fly Pest in Australia," which had been written some time previously.

It was not however until about the middle of this year that the sheep-owners took any steps to investigate the matter from a scientific point of view; though

it was publicly stated at their first meeting that during the previous year the loss in wool and sheep, at a very low estimate, was a million pounds in New South Wales alone, and it was just as bad in Queensland, and spreading into the other States.

In July 1913, a public meeting of pastoralists was convened, at which a committee of station-owners was formed to consider what methods should be adopted to deal with this serious pest, and a deputation waited upon the Minister of Agriculture to ask for assistance and co-operation. He agreed to their request, and through the Experiments Committee appointed the Chief Inspector of Stock, the Government Entomologist, and the Sheep and Wool Expert, to draw up a scheme of operations and submit it for his consideration. The establishment of an Experiment Station in the centre of an area infested with sheep-maggot fly was approved; and a scientific investigator to take charge, and a camp assistant to look after the station, were appointed by the Government.

As most of the preliminary work was of an entomological nature, the details, as well as the establishment of the camp, were left in my hands, and a circular was sent out to the district Stock Inspectors making enquiries as to suitable sheep stations in their respective districts where a camp could be formed.

The Brewarrina district was chosen, and accompanied by the Stock Inspector, I visited Yarrawin Station on Marrar Creek, about 36 miles from Brewarrina. Through the kindness of Messrs. W. and T. Dickson we were enabled to select a very suitable site near the crutching yards, where large numbers of sheep were yarded and dressed.

My son, Mr. J. L. Froggatt, who had specialised in bio-chemistry, was appointed Officer in Charge of the Government Sheep-Maggot Fly Experiment Station, and the camp attendant, Mr. A. Lucas, holds a certificate as a Stock Inspector. The Experiment Station consists of a camp containing two large living tents, a laboratory tent, and a kitchen tent. The idea of using tents was that the camp could be moved to another district, if required, with very little expense.

Field investigations along various lines were commenced towards the end of September, and the writer has himself been spending nearly half his time in camp, studying the life-histories, range and habits of the different flies which occur in the district among the sheep, and examining all dead animals, offal, and animal remains found in the paddocks. The Experimentalist is working on the chemical side of the question, studying the different combinations of substances and chemicals that can be used to attract flies to poisoned baits, or to keep them from laying their eggs or maggots upon wool. While a number of experiments have up to the present given only negative results, it is only a question of time before some combination will be found that may be as attractive as the odour of the wool upon the sheep.

There are many important points that will be dealt with during these experiments; such as the value of the different indigenous birds that are credited with destroying flies or maggots; the best methods to be adopted in laying poison baits for rabbits, dingoes, and foxes; and the value of natural parasites upon the flies, maggots and pupae.

Among the predaceous enemies of these flies there are several interesting species, such as the Staphylinid beetle (*Creophilus erythrocephalus*), popularly known as the "Devil's Coach-horse." These carnivorous beetles are most plentiful under the smaller dead mammals and birds, and must account for a large number of maggots during the season, for in captivity they seize a maggot as soon as it is dropped into the jar.

Another enemy of the adult sheep-maggot fly is the small, metallic dark bronze, sand-wasp, a species of the genus *Gorytes* (family NYSSONIDAE), known in the bush as the "Policeman Fly," on account of the rapid manner in which it can snap up a fly from the back of one's hand with its powerful jaws, and carry it off to its nest. The sheep-owners report that they often notice these wasps on the sheep catching the sheep-maggot flies, but it would require a large army of these insects to do much good.

The most important parasite (recently discovered) is a minute, metallic bronzy-green Chalcid wasp with yellow legs and antennae that infests the larvae and pupae of the Hairy Maggot (*Calliphora rufifacies*). These tiny little parasites lay their eggs in the larva or pupa of the fly, and from a large number of pupae examined an average of twenty Chalcid wasps in all stages of development were obtained from each. Many thousands of these parasites have been bred out in the Laboratory of the Experiment Station at Yarrawin, and at the Insectarium in Sydney, and have been supplied with quantities of adult fly maggots which they readily parasitised in the breeding cages. Large quantities of these parasitised pupae were obtained under the remains of a dead fowl, that had been lying in the paddock about five weeks; they were dry and hard, resting on the surface of the soil under the decomposed animal matter, among a number of empty pupa cases from which the sheep-maggot flies had emerged.

The importance of the discovery of this valuable indigenous parasite, attacking another native insect under natural conditions, and that can be readily transported and bred in captivity, can hardly be over-estimated. Here there is every condition that should lead to the balance being restored in the sheep paddocks, particularly if we can assist the parasite; for the chances of success are far greater than if we had to depend upon the establishment of an introduced parasite. The practical way for our sheep-owners to utilise this discovery of the officers of the Experiment Station is for them to examine the remains of every dead animal they find in going round these paddocks, and to ascertain whether the pupae of the sheep-maggot fly are being parasitised. If parasites are present, the pupae will be found to contain a number of small maggots or small winged ant-like creatures, instead of the remains of a single fly. In that case, the best way to help in the propagation of the parasite is to sweep up all the pupa cases found under the remains of dead animal and the earth just underneath (which often contains pupae) and place them in a bag made of mosquito netting; then tie up the neck of the bag and hang it in the branch of a tree or on a fence. The sheep-maggot flies on emergence from the pupae are caught in the mesh of the net and die, while the smaller parasites can easily creep through the holes and fly away to seek fresh prey in which to lay their tiny eggs.

At the time of our discovery of this parasite in the North-West district of New South Wales, a similar parasite was recorded from Longreach, Central Queensland, so that the range of this useful insect may be very wide, and though at present we know little of its habits, it may have always been a destroyer of blow-fly maggots. In some instances it may have been the cause of the marked diminution or complete disappearance of sheep-maggot flies that has sometimes been recorded from districts which were previously badly infested.

ON SOME SPECIES OF CACODMUS, A GENUS OF BEDBUGS (CLINOCORIDAE).

By The Hon. N. C. Rothschild.

In the Entomologists' Monthly Magazine, (2) xxiii, p. 85 (1912), I described as *Cacodmus ignotus*, sp. nov., a female without locality and compared it with *Cacodmus villosus*, Stål. The Imperial Bureau of Entomology has lately received from Uganda a pair of a *Cacodmus*, taken from a bat by Mr. C. C. Gowdey, which differs so little from the specimen described as *ignotus*, that I consider the two examples to belong to that species.

C. ignotus is larger and much more elongate than *C. villosus*, the sides of the pronotum and of the elytra are slightly less rounded and the hind tibia is somewhat longer than the femur. The differences in the proportional lengths of the antennal segments appear to be less constant and therefore of less importance than I at first considered them to be. The segments, moreover, are very difficult to measure, as a slight deviation of a segment from a horizontal position renders the measurement incorrect.

The most conspicuous difference between *ignotus* and *villosus* is the organ of copulation of the male. In *villosus* (fig. 4) this organ reaches somewhat beyond the centre of the sixth abdominal segment, and the groove in which it rests extends to the base of the sixth segment, being covered by the apex of the fifth segment. In *C. ignotus* (fig. 5) the penis groove only extends to the base of the seventh segment, and the penis itself reaches just a little beyond the centre of that segment. The penis of *C. ignotus*, moreover, is half as thick again near the base as in *C. villosus*.

The male recorded by me in Ent. Mo. Mag. xxiii p. 86, as a doubtful *C. villosus*, and contained in the Cambridge Museum, belongs to *C. ignotus*.

acodmus sparsilis, sp. nov. (fig. 3).

Cacodmus villosus, Roths., Ent. Mo. Mag. (2) xxiii, p. 86 (1912) and xxiv, p. 102 (1913) (*partim*).

A female in the collection of the British Museum which I have hitherto considered to be a female of *C. villosus* exhibits some very trenchant differences from true *villosus* now that it is mounted in balsam, and doubtless represents a new species.

The specimen is rather smaller but more elongate than *C. villosus*, and the bristles of the body are less numerous as well as somewhat shorter than in that species. The sides of the pronotum are less rounded (fig. 3) and the anterior angle more produced. The curved incrassation within the prothorax, placed in front of the coxal groove, is farther away from the apical angle of the prothorax than is the case in *C. villosus* and *ignotus* (cf. figs 1, 2 and 3). The elytra are very strongly rounded laterally, there being no indication of a lateral angle (fig. 3), while the lateral ridge present on the under surface is hardly at all widened anteriorly. The two irregular rows of bristles of the pronotum which are nearest the apical edge contain about 30 bristles altogether, while the number is more than 50 in *villosus*. The corresponding two rows of bristles along the basal edge of the elytra from the central projection of the scutellum to the point where the margin curves forward, contain in *sparsilis* about 18 bristles, and in *villosus* about 30. The hind tibia is slightly longer than the hind femur.

One female in the British Museum from Port Natal, off *Vespertilio dinyani*.

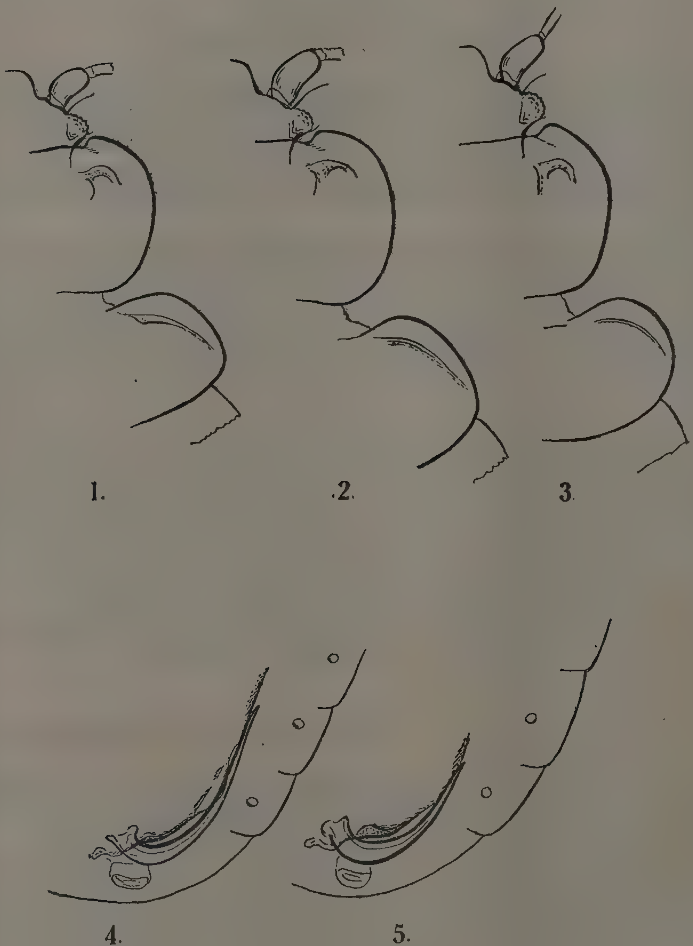


Fig. 1. *Cacodmus villosus*, ♀; Transvaal.
„ 2. „ *ignotus*, ♀, type; locality unknown.
„ 3. „ *sparsilis*, ♀, type; Natal.
„ 4. „ *villosus*, ♂; Nyasaland.
„ 5. „ *ignotus*, ♂; Uganda.

DESCRIPTION OF A NEW FROGHOPPER FROM BRITISH GUIANA.

By F. W. Urich.

Entomologist, Board of Agriculture, Trinidad.

Tomaspis flavilatera, sp. nov.

The adult (fig. 1) is of a light brown colour, with lateral tawny markings forming a narrow border on the outer margin of each tegmen and extending from the base to within one-third of the apex. The anterior part of the tawny margin is slightly broader than the rest. The tegmina are translucent with the usual reticulations at the apex. Head, pronotum and abdomen darker than tegmina. The abdomen shows through the latter and gives the anterior part of the tegmina a darker colour. Head darker than pronotum with a bronzy sheen. Pronotum rugose. The profile of the face (fig. 1) is constant. Length 8·5 to 8·75 mm.

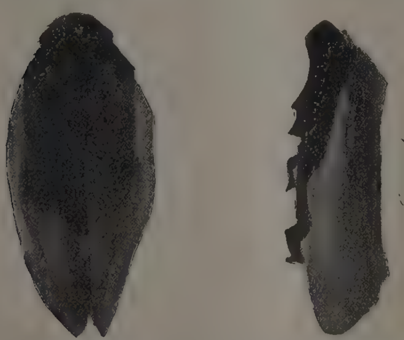


Fig. 1. Dorsal and lateral view of *Tomaspis flavilatera*, sp. nov., ♂, × 6. The tegmina are slightly distorted by shrinkage in drying.

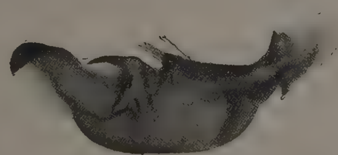


Fig. 2. Outer lateral view of left harpe (Leitz, oc. I. obj. 3).

The male genitalia offer the best and most constant characters for the separation of species of this genus. Fig. 2 represents one of the harpes, which are very much contorted. The object was mounted in balsam without pressure; the parts appearing dark in the figure are strongly chitinised.

British Guiana: on grass and occasionally on sugar-cane.

Described from numerous specimens collected by Messrs. J. J. Quelch, G. E. Bodkin, F. A. Stockdale and H. W. B. Moore.

Type in the British Museum.

THE RESPIRATORY SYSTEM OF MONOPHLEBUS STEBBINGI, VAR. OCTOCAUDATA.

By Robt. E. Savage.

(Plates V–IX.)

Monophlebus stebbingi, Green, var. *octocaudata*, Green, is a large Coccid belonging to the sub-family Monophlebinae. It is found on Mango, Jack Fruit, and species of *Ficus*, in India, but having, for a Coccid, a long life-history—being but single-brooded—it is rarely a pest. Climatic conditions govern the production of large numbers of individuals, so that outbreaks are irregular, occurring at intervals of a few years.

Its gigantic proportions, compared with other Coccids—the fully-ripe female often reaching a length of 2 cm.—led Professor Lefroy to suspect that the tracheal system might differ from the usual arrangement found in Coccids, and upon investigation, this was found to be the case.

In all other Coccids, with two exceptions mentioned by Newstead,* there are but two pairs of spiracles—the mesothoracic and metathoracic, situated ventrally just posterior to the junction of the pro- and meso-sternum and the meso- and meta-sternum respectively. The two exceptions are *Stigmacoccus*, Hempel, and *Perissopneumon*, Newstead; the former has, in addition to the thoracic, eight pairs of dorsal abdominal spiracles, while the latter has seven pairs. In the species under consideration there is also this supplementary dorsal series, seven pairs being present.

1. The General Arrangement of the Tracheal System.

This is shown in the figure on Plate V. Only the main trunks and branches are indicated, as the minor branches with their ramifications amongst the internal organs form a very complex system, and it would serve no useful purpose to try to represent them.

Each *mesothoracic spiracle* leads into a short wide trunk, which immediately branches; one branch divides again, and passes anteriorly to the head and mouth-parts, a second branch passes towards the middle line and joins its fellow from the other side, thus forming the mesothoracic transverse tracheal trunk; a third main branch passes posteriorly and unites with an anterior branch from the trunk into which the metathoracic spiracle leads, thus forming a longitudinal thoracic tracheal trunk.

Each *metathoracic spiracle* leads into a trunk which divides immediately into four main branches. One of these, as we have seen, helps to form the longitudinal trunk of the thorax; a second helps to form, as in the mesothorax, a transverse trunk a third and fourth branch pass backwards into the abdomen as a dorsal and ventra trunk; the dorsal abdominal trunks of each side unite posteriorly.

Each *spiracle of the abdominal series* of seven pairs, leads into a narrow tracheal tube, which soon bifurcates, giving rise to a dorsal and a ventral branch, which join the dorsal and ventral abdominal trunks respectively. The ventral branches from the last three spiracles join the ventral abdominal trunk at the same point. A transverse trachea tube connectsthe dorsal branches leading from the last pair of abdominal spiracles, just posterior to the anus.

The arrangement of the spiracles is the same in both male and female insects.

* Newstead, "Monograph of British Coccidae," i, 1900, p. 15.

2. The Structure of the Thoracic Spiracles.

The structure of the thoracic spiracles was studied (1) by means of whole mounts of the spiracles, obtained by dissecting them out and then boiling in 10 per cent. KOH solution; and (2) by longitudinal and transverse sections of the spiracles (Plates VII and VIII). Horizontal sections were not procured because of the difficulty of obtaining them really horizontal. Two fixatives were used:—(1) Corrosive acetic alcohol, and (2) boiling picro-sulphuric (Kleinenberg's formula). The best results were obtained by using the former. Embedding for seven hours in paraffin wax of melting point 58° C. was found to be very satisfactory.*

The thoracic spiracles are situated on the ventral surface of the insect near the lateral margin, the mesothoracic just behind the junction of the pro- and meso-sternum, and the metathoracic just posterior to the junction of the meso- and meta-sternum. The aperture is laterally placed, whilst the "muscle plate" (see below) is ventral and somewhat anteriorly directed (Plate V, fig. 2). In the adult insect the spiracles are in grooves of the integument (Plate VI, fig. 4).

The aperture of the spiracle is surrounded by a chitinous rim (Plate VI, figs. 3, 4-C_1), which is continuous ventrally with what will be called the *muscle-plate* (C_2), a very strong and thick chitinous structure, which, as will be seen below, serves for the attachment of the muscles in connection with the closing apparatus. The aperture leads into a chamber (D) which will be called the *collar chamber*; this cavity extends on each side (figs 3 and 4), and is well shown in section on Plate VII, figs. 5, 6, 11 and 12. From the base of the collar chamber in the median part arise two *jaws* for closing the entrance to the tracheal trunk—a ventral and a dorsal. The *ventral jaw* (Plates VI, VII, VIII–A) is only strongly chitinised on the surface nearest the aperture (Plate VII, figs. 7–10, A). The *dorsal jaw* (Plates VI, VII, VIII–B) is strongly chitinised on both surfaces and is rigid; it is always placed behind the ventral jaw (Plate VII, figs. 7–10). In fig. 3 on Plate VI, the spiracle has been pressed somewhat, so that jaw A does not appear to be in front of jaw B. The dorsal jaw is semi-circular (Plate VI, fig. 4) and ends in two processes (E) which apparently are attached to muscles in connection with the muscle plate, as is indicated in the section figured on Plate VIII, fig. 16.

The two jaws guard the entrance to the tracheal tube, but lead first into a cavity (Plate VII, fig. 8; Plate VIII, fig. 16, F), in the ventral wall of which muscles (M) are inserted; these muscles are attached at their other extremities to the muscle plate; they are extremely well-developed and almost certainly cause by their contraction the closure of the spiracle. Upon contraction the ventral jaw (A) (which as stated above is only strongly chitinised on its outer surface) is pulled down on to the dorsal jaw (B) which is practically rigid, and the closure of the aperture effected. In some sections obtained the two jaws are in apposition, and this lends support to the above statement. It is very probable that the two processes of the dorsal jaw (E–Plate VI, fig 4; Plate VIII, fig 16), mentioned above as being attached to the closing muscles, are pulled inwards and thus cause a more effective closure of the aperture.

The tracheal trunk arises from the cavity F and immediately branches (Plate VI, fig 3). It is at first surrounded by a layer of cells with large nuclei.

On Plate VIII, fig. 21, is a reconstruction intended to show the relations of the transverse series of sections to a longitudinal section. It explains the peculiar appear-

*All the sections were cut in the summer months.

ance of the muscle plate in Fig. 20. This transverse series (obtained from longitudinal sections of the insect) also show well the groove of the integument in which the spiracle lies and the relations of the collar chamber with the external aperture.

3. The Structure of the Abdominal Spiracles.

There are seven pairs of abdominal spiracles situated on the dorsal surface, near the lateral margins of the insect and near the junctions of the abdominal segments, but there is no spiracle at the junction of the metathorax with the first abdominal segment.

The external opening is surrounded by a chitinous rim; this leads into a chamber (=collar chamber of thoracic spiracles) the walls of which are raised into a prominent spiral thread (Plate IX, figs. 22, 23). Projecting into this cavity is a number of teeth,—eight to ten—which are united at their bases; their free pointed ends almost approximate, leaving a narrow pore—the opening into the tracheal tube (Plate IX, figs. 22, 23, 26). The first part of the tracheal tube is very narrow in the sections examined, and is surrounded by a layer of spindle-shaped cells (G), which suggest a muscular function, and it is highly probable that the teeth are brought together and the narrow lumen occluded by the relaxation of these cells. The teeth appear to bend over to one side as is shown in transverse and longitudinal sections (Plate IX, figs. 22, 26).

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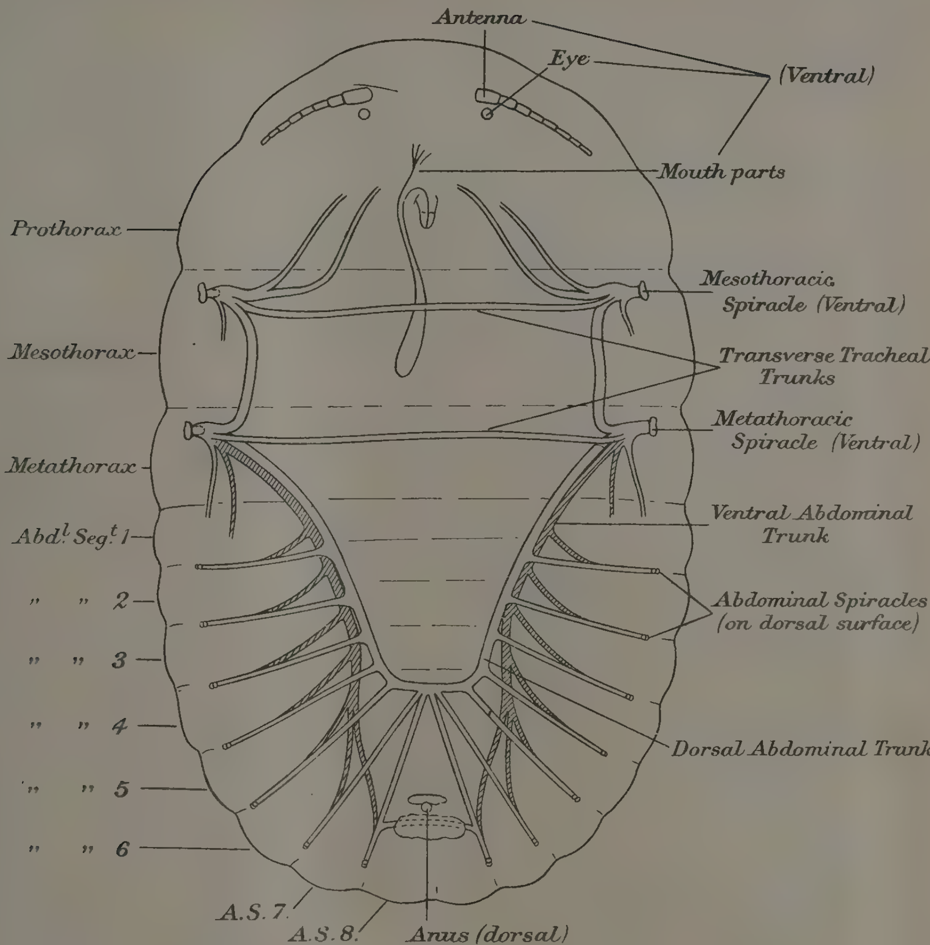
EXPLANATION OF PLATES V–IX.

Monophlebus stebbingi, var. *octocaudata*, Green.

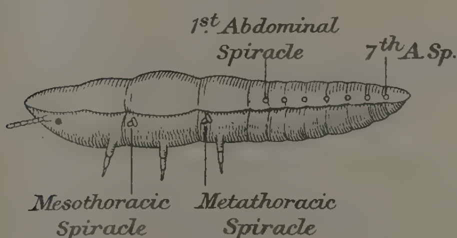
Fig. 1. Diagrammatic representation of tracheal system, viewed from dorsal surface; legs removed.
2. Lateral view of insect to show position of spiracles.
3. Thoracic spiracle; seen from ventral surface.
4. ,, ,, plan (lateral view of insect).
5–12. Longitudinal sections of thoracic spiracles.
13–20. Transverse ,, ,, ,,
21. Diagram to show direction of sections 13–20.
22–23. Longitudinal sections of abdominal spiracles.
24–30. Transverse ,, ,, ,,

A. Ventral jaw.
B. Dorsal jaw.
C_1. Rim of spiracle.
C_2. Muscle plate.
D. Collar chamber.
E. Processes of dorsal jaw.
F. Tracheal cavity.
G. Muscular tissue of abdominal spiracle.
H. Spiral wall of collar chamber of abdominal spiracle.
J. Teeth of abdominal spiracle.
K. Collar chamber of abdominal spiracle.
M. Muscles of closing apparatus.
T. Trachea.



1

Dorsal view (legs removed.)



2

Lateral view

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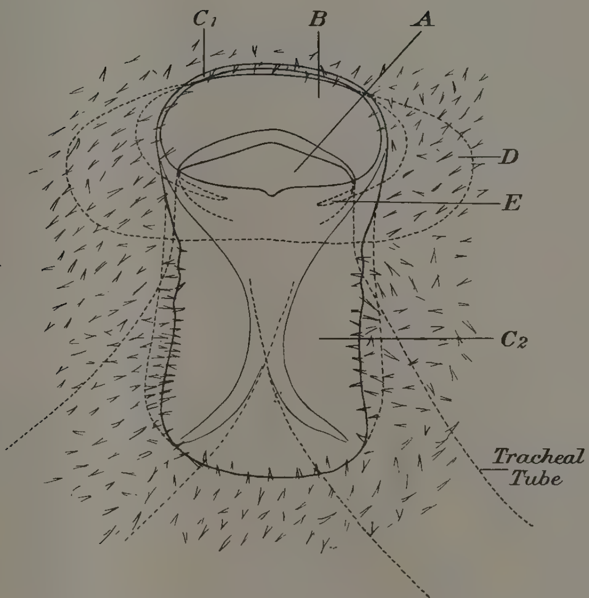
DIAGRAMMATIC REPRESENTATION OF THE TRACHEAL SYSTEM OF MONOPHLEBUS STEBBINGI.



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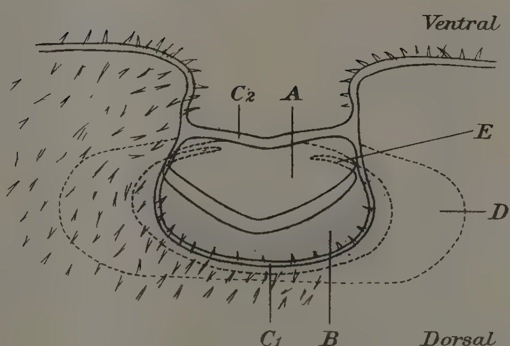
View from Ventral Surface



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Plan of Spiracle
(lateral view of Insect)

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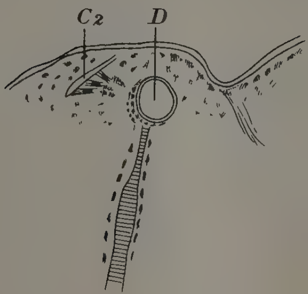
THORACIC SPIRACLE OF MONOPHLEBUS STEBBINGI.



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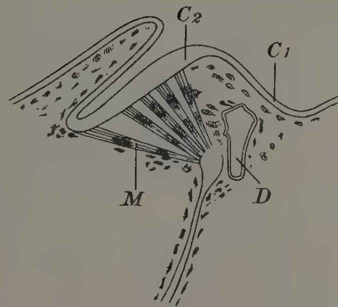

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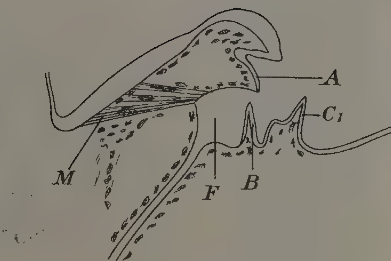

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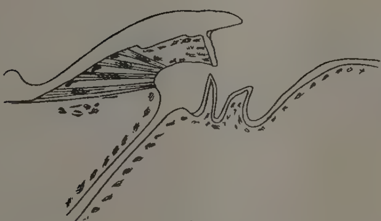

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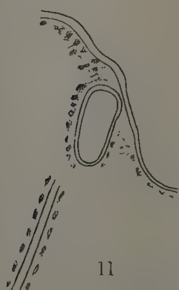

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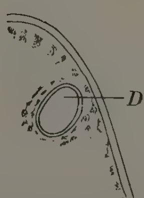

12

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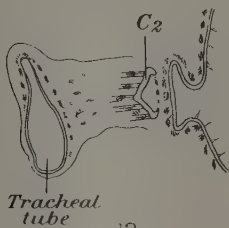
LONGITUDINAL SECTIONS OF THORACIC SPIRACLE.



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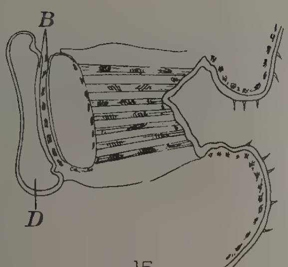

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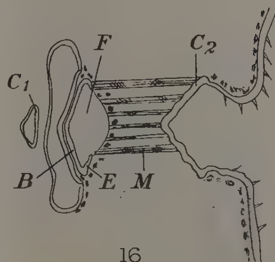

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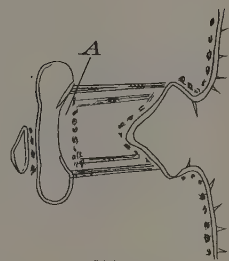

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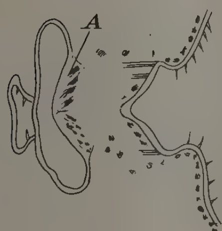

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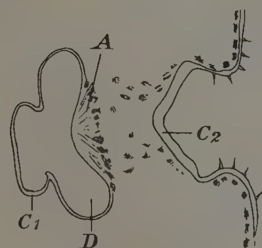

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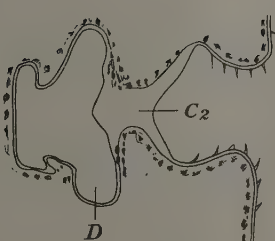

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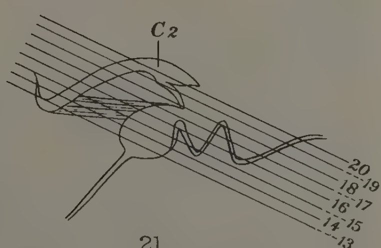

21

Diagram to show direction of sections 13-20

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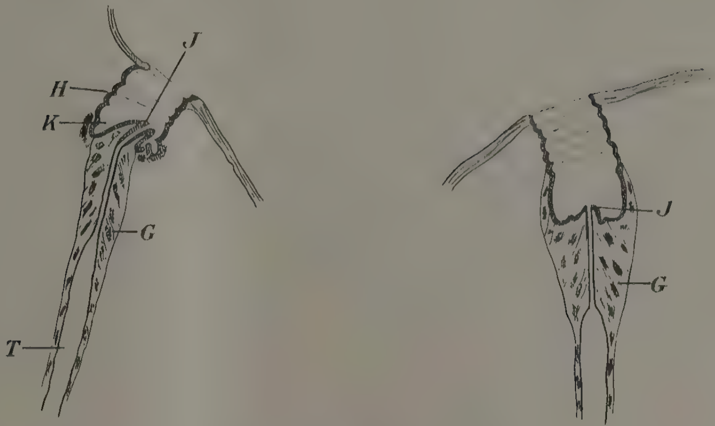
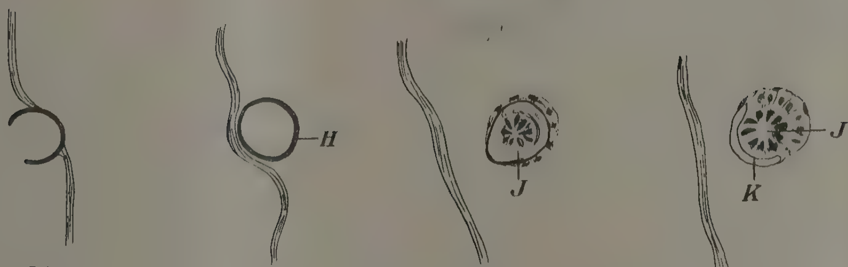
TRANSVERSE SECTIONS OF THORACIC SPIRACLE.



22 Longitudinal Sections 23



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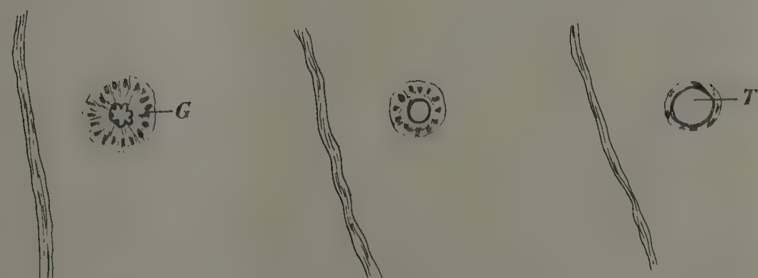

28 29 30

Transverse Sections

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ABDOMINAL SPIRACLES OF MONOPHLEBUS STEBBINGI.

FURTHER NOTES ON THE BIONOMICS OF GLOSSINA MORSITANS IN NORTHERN RHODESIA.

By Ll. Lloyd,

Entomologist to the British South Africa Company in Northern Rhodesia.

(Plates X-XIII, and Map.)

Since the cessation of the work of the Luangwa Sleeping Sickness Commission in Northern Rhodesia the investigation into the bionomics of *Glossina morsitans* has been carried on at Ngoa, in the Mpika Division, on the high ground of the Congo-Zambezi watershed. The work included a study of the influence of various bloods on the breeding capabilities of the fly and further investigation of the breeding habits and haunts of the insect in nature. The following notes embody the results of the work during the eight months from January to August, 1913. The climatic conditions during this period are given in Table 1, the temperatures being those of the laboratory.

Table 1.

Showing the Temperature and Rainfall at Ngoa, 1913.

	Laboratory Temperatures.			Rainfall.
	Av. Max.	Av. Min.	Mean.	
January .. .. .. (15th–31st)	..	..	..	3·85 in.
February	72·7° F.	64·8° F.	68·7° F.	5·86
March	71·1°	64·2°	67·6°	10·40
April	73·6°	64·2°	68·9°	0·77
May	71·2°	59·2°	65·2°	0·82
June	65·7°	50·1°	57.9°	0·00
July	64·4°	51·8°	58·1°	0·00
August	70·2°	58·0°	64·1°	0·00

Influence of Various Bloods on Breeding Capabilities.

In the method which was adopted, a definite number of freshly caught female flies were fed on goats, monkeys, fowls, ducks and chameleons. In most of the experiments the flies were kept in the usual type of fly bottle, four females and two males in each. A few of the series were kept in large wooden cages with fronts of mosquito muslin. Records were taken of the length of life of each fly in captivity and the numbers of pupae and aborted larvae which were deposited; each pupa was also measured. Nineteen experiments were commenced, of which thirteen were completed. The original intention was to breed the flies through more than one generation on the various bloods, but owing to removal to another part of the country, this was possible only to a very small extent.

Pupae were produced in small numbers, especially from June to August, which are the coldest months of the year, when some of the series did not produce a single pupa. The doors and windows of the laboratory were made of loose reeds, so that the flies were exposed to the full cold at night and obtained no direct benefit from the sun in the daytime, as do the flies in nature. Pupae were being found in the bush in considerable numbers during July and August, while during the rains breeding was not active. The artificial conditions in the laboratory thus tended to reverse what takes place in nature. The influence of the low temperatures is shown in Table II, in which

are given the percentages of pupae to the number of female flies in captivity in each month. In spite of the small numbers of pupae produced at any time, the influence of the temperature is very apparent.

TABLE II.

Showing the Influence of low Temperature on the Breeding of G. morsitans.

Month.	Average number of ♀ flies in captivity.	Number of pupae produced.	Percentage of pupae to ♀ flies.	Temperature.
January ..	48	3	6·3 per cent.	69° F. (approx.)
February ..	87	11	12·7 "	69°
March ..	109	31	24·5 "	68°
April ..	154	22	14·3 "	69°
May ..	242	24	9·9 "	65°
June ..	416	19	4·6 "	58°
July ..	424	19	4·5 "	58°
August ..	210	18	6·1 "	64°

Pregnant female flies are not often caught and in captivity usually abort the first larva. No fly produced a healthy larva till after 15 days' captivity. This would account for the low percentages in January and February compared with that of March. A large number of the flies did not breed at all. In the series which bred most freely (No. 2, on goats' blood) the breeding was confined to 15 flies, 70 per cent. of them producing no larvae or only one or two abortions. The fly does not seem to be at all amenable to captivity in this district.

There is a tendency in the insect to overfeeding in captivity and this is difficult to control when several require food in the same bottle. On three occasions they have been known to feed till an internal rupture of the gut was caused. In two of these instances the blood donor was a duck and in the third a fowl. In two of them which were dissected the rupture had occurred in the sucking stomach. The result of such a rupture is that the blood flows throughout the haemocoel and the whole insect takes on a ruddy tinge. One of the flies lived for seven days in this condition but in the others death followed the rupture at once.

Of the 19 series used, five (400 ♀ flies) were fed on goats, four (250 ♀ flies) on monkeys, five (250 ♀ flies) on fowls, four (250 ♀ flies) on ducks, and one series (52 ♀ flies) on chameleons. The full details of the experiments are given in Table III. Goats were used as representatives of the larger, and monkeys as smaller, mammals. Crocodiles would have been more suitable as representatives of the reptiles than the chameleons which were used, but none could be procured. The flies did not feed well upon the lizards. This was not due to the lack of a desire to feed, but to the difficulty of obtaining the blood, a fly frequently inserting its proboscis into several different parts of the animal and finally giving up in despair. Rather more than 50 per cent. of the 77 flies used did not feed at all. One fly, a female, lived for twenty-three days, taking food on six occasions, while only six survived ten days captivity. It was very rarely that a fly distended itself fully with the blood. They usually ceased to feed when a slight pinkness showed on the ventral surface of the abdomen. No larvae were deposited.*

* Cf. Kleine, Deutschen Medizinischen Wochenschrift, No. 45, 1909.

TABLE III.

Showing the Influence of various Bloods on the Life and Breeding of G. morsitans.

Number of Series.	Animal used as food.	Duration of experiment.	Number of female flies used.	Number of male flies used.	Average life of female flies.	Average life of male flies.	Longest life in captivity.	Number of pupae produced.	Dimensions of the Pupae. Average. Length.	Dimensions of the Pupae. Average. Breadth.	Dimensions of the Pupae. Maximum.	Dimensions of the Pupae. Minimum.	Number of abortions produced.	Mean temperature during experiment.
1	Goats	14.i-30.v	50	46	48·4 days	30·0 days	135 days	13	5· 7 mm.	3·13 mm.	6·0×3.4 mm.	5·3×3.0 mm.	12	68° F.
2	,,	30.i-30.v	50	37	46·1 ,,	37·1 ,,	114 ,,	24	5· 8 ,,	3·18 ,,	6·1×3.5 ,,	5·5×3.0 ,,	13	68°
3	,,	21.iv-25.viii	50	35	58·7 ,,	38·5 ,,	124 ,,	9	5·76 ,,	3·15 ,,	6·0×3.5 ,,	5·2×2.9 ,,	9	61°
4	,,	21.v —*	100	50	—	—	—	15	5·68 ,,	3·18 ,,	6·0×3.6 ,,	5·2×2.9 ,,	5	60°
5	,,	7.vii —*	150	55	—	—	—	7	5·88 ,,	3·28 ,,	6·0×3.4 ,,	5·8×3.1 ,,	1	60°
6	Monkeys	8.iv-27.vi	50	28	22·7 ,,	18·7 ,,	79 ,,	7	5·63 ,,	3·10 ,,	5·9×3.2 ,,	5·3×3.0 ,,	4	64°
7	,,	2.v-24.viii	50	35	37·1 ,,	26·6 ,,	105 ,,	5	5·55 ,,	3·13 ,,	5·8×3.1 ,,	5·2×3.1 ,,	2	61°
8	,,	3.vi —*	50	39	—	—	—	1	—	—	5.9×3.6 mm.		0	59°
9	,,	5.vi —*	100	41	—	—	—	5	5·78 ,,	3·24 ,,	6·1×3.5 mm.	5·4×2.9 ,,	1	59°
10	Fowls	1.i-21.v	50	29	41·0 ,,	30·0 ,,	137 ,,	15	5·40 ,,	3·00 ,,	5·9×3.2 ,,	5·0×2.8 ,,	7	68°
11	,,	14.ii-31.v	50	34	38 1 ,,	30·9 ,,	100 ,,	17	5·60 ,,	3·08 ,,	6·1×3.5 ,,	5·1×2.7 ,,	13	68°
12	,,	10.iv-5.viii	50	30	46·6 ,,	32·5 ,,	112 ,,	11	5·54 ,,	3·05 ,,	6·0×3.4 ,,	5·0×2.9 ,,	5	62°
13	,,	19.v-29.viii	50	31	47·1 ,,	32·3 ,,	101 ,,	2	5·20 ,,	2·80 ,,	5.2×2.8 mm.		1	60°
14	,,	12.vi-26.viii*	50	24	—	—	—	0	—	—	—	—	0	59°
15	Ducks	12.iii-8.vii	50	30	53·8 ,,	48·8 ,,	108 ,,	11	5·61 ,,	3·06 ,,	6·2×3.4 mm.	5·3×2.9 mm.	13	64°
16	,,	25.iv-25-viii	50	27	53·0 ,,	41·0 ,,	117 ,,	5	5·54 ,,	3·02 ,,	6·0×3.3 ,,	5·2×2.8 ,,	4	61°
17	,,	28.v —*	75	41	—	—	—	0	—	—	—	—	0	59°
18	,,	16.vi —*	75	37	—	—	—	0	—	—	—	—	0	59°
19	Chameleons	30.xii-23.i	52	25	4·2 ,,	3·6 ,,	23 ,,	0	—	—	—	—	0	69° (apprx.)

* Conducted in wooden cages; only No. 14 of these was completed.

In the series fed on goats, fowls and ducks there was little difference in the average life of the flies. The best results in this respect were given by the two series (Nos. 15 and 16) on ducks and one series (No. 3) on goats. The flies fed upon monkeys died much more rapidly, though they feed readily on these animals, often doing so when they will not take food from a goat. The low temperatures did not appear to affect the length of life of the flies, though in the coldest weather they were very sluggish and would not feed until they had been warmed by the sun.

A comparison of the numbers of pupae produced, making due allowance for the temperature, shows that mammalian blood has no definite advantage over avian in this respect. Those fed upon goats bred a little more freely than those fed upon fowls and ducks; while those fed upon monkeys were less prolific. On the average the pupae produced on mammalian blood are larger than those bred on avian blood. This advantage is four per cent. in length and five per cent. in breadth (Table IV). The difference is obvious in the flies which emerge from the bred pupae. In Table IV the dimensions of 50 pupae collected in nature are included for comparison.

Table IV.

A Comparison of the Dimensions of Pupae bred on Mammalian and Avian Blood.

Source of Pupae.	Number.	Average length.	Average breadth.
Collected in nature ..	50	6·01 mm.	3·40 mm.
Bred on goats	68	5·76 ,,	3·18 ,,
,, ,, monkeys ..	18	5·66 ,,	3·17 ,,
Total bred on mammals	86	5·74 ,,	3·18 ,,
Bred on fowls	45	5·50 ,,	3·03 ,,
,, ,, ducks	16	5·59 ,,	3·05 ,,
Total bred on birds ..	61	5·52 ,,	3·04 ,,

In the avian series there was a large proportion of very small pupae. Of these 22 (36 per cent.) measured 5·5 mm. or less in length, while in the mammalian series 11 (13 per cent.) only were of these dimensions. The avian series however also included a few pupae which were equal in size to the largest bred on mammals' blood.

The small size of these pupae is considered to be due to the pressure of the clots of blood which form in the sucking stomachs of some of the flies when fed on avian blood.* A fly containing such a clot has the appearance of being newly and fully fed. Their formation appears to be due to an individual peculiarity of some of the flies. The following experiment shows the permanence of the clots when once formed. A cage of 100 tsetse were fed for 20 days on fowls and then starved for ten days. At the end of this period 75 of the flies were dead. They were then examined and of the total 62 were found to have clots in the sucking stomachs, while the remaining 38 were thin. Among the 25 living flies 12 contained clots. Fifty flies which had been fed on monkeys' blood for 50 days were similarly starved for ten days. Only one of the flies remained alive and examination showed that all of them were thin and contained only blood detritus.

* Ann. Trop. Med. and Parasitology, vii, no. 2, p. 285.

When a fly containing a blood clot is dissected, the distortion of the contents of the abdomen is found to be considerable. In an extreme case the viscera are pressed into a flat mass against the dorsal body-wall and come away in a cake. If an attempt is made to unravel the gut it is found to be much flattened and breaks repeatedly. The small development of the fat-body is evidence of malnutrition. Thee ffect on the generative organs of the female is very apparent. The ovaries of a newly emerged fly consist of a couple of pear-shaped bodies, the broad ends of which are connected with the short thick oviduct which enlarges into the uterus. The spermathecae, a pair of chitinised capsules, are connected but have separate short ducts which open close together into the anterior end of the uterus on the ventral surface. The branched tubular system which secretes the food of the developing larva is closely attached to the uterus and opens into it on a papilla just posterior to the opening of the spermathecal ducts. The system and the development of the eggs and larvae have been very fully described in the case of *G. palpalis*.* As the generative products mature, an egg in each ovary grows considerably in size, one being usually more advanced than the other. The mature egg is of the typical Muscid form, being elongated and slightly kidney-shaped. In the case of a female fly which contains a large clot, the ovaries are doubled forward over the uterus in such a way that the mature egg is unable to pass down. The eggs however continue to develop and the oldest one becomes crushed completely out of shape (fig. 1). In

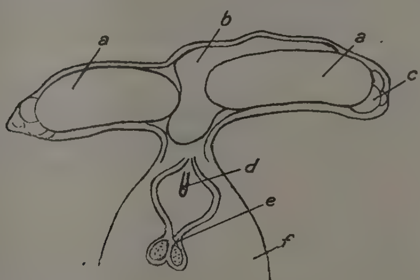

Fig. 1. Showing the effect on the developing eggs of *G. morsitans* of a blood clot in the sucking stomach; ventral view:—*a*, *a*, fully developed healthy eggs; *b*, oldest egg crushed by pressure; *c*, undeveloped eggs; *d*, duct of feeding tubes; *e*, spermathecae; *f*, uterus.

the case figured the first egg is seen to have been partly forced into the oviduct, completely blocking up the lumen. In two instances in which pupation of the larvae commenced in the uterus the effect of the pressure was well marked. Pupation was not completed in either case, the cuticle of the larvae becoming dark, but remaining of a leathery texture. In one of these the pressure of the ovaries on the uterus had caused a deep depression in the larva just posterior to the mouth. In the other case the posterior cap was doubled over laterally with one of the protuberances pressing against the body of the larva. Considering the frequency with which the clots are formed it is remarkable that a diet of avian blood compares so favourably with a diet of mammalian blood.

* Minchin, Proceedings of the Royal Society, Vol. B76, p. 543; Roubaud, La Maladie du Sommeil, 1909, pp. 427–452.

In the attempt to obtain a second generation on the various bloods, twenty couples which had been bred on birds and the same number from the goat series were fed on the blood of fowls and goats respectively. Each experiment was continued for five months, flies being added as they emerged. None of those which were feeding on the goats became pregnant, while in the fowl series one aborted larva and one healthy pupa were produced. The pupa from which the parent of the latter emerged measured in length 5·6 mm. and in breadth 3·0 mm. The offspring measured 6·0 mm. in length and 3·2 mm. in breadth. What little evidence there is therefore shows that there would not necessarily be progressive degeneration in size on a continued diet of avian blood.

Relation of the fly to the smaller animals.

These experiments point to the conclusion that the advantages of a mammalian diet as opposed to an avian one are not great and are due to the fact that mammalian blood is more easily digested than avian. Under natural conditions however it is not likely that the overfeeding which takes place in the laboratory would occur. While the fly is apparently unable to carry on its species on a reptilian diet, occasional meals of such blood would assist the individual in prolonging life.* The dependence of the tsetse-fly on the larger mammals therefore depends on the ability of the smaller mammals, birds and reptiles to avoid the insect. The behaviour of some of the smaller animals when placed in a cage with tsetse was studied in the laboratory. The flies used were freshly caught and most of the experiments were carried out in a glass cylinder ten inches high and six inches in diameter. The results of these were as follows :—

A. With mammals.

(1) Ten flies, three or four at a time, were introduced into the jar containing an adult wild rat ; all were quickly caught and eaten, none of the flies having any chance of feeding. The experiment was repeated twice with the same result.

(2) Four flies were placed in the jar with a young wild rat, just weaned ; the flies were caught and killed but not eaten. Ten flies were used and none fed.

(3) A burrowing rodent (a species of MURIDAE) was placed in the jar with four flies ; although of sluggish habits it at once became very alert. Two of the flies were caught and killed at once but not eaten ; one escaped and the other was killed later. The experiment was repeated with 20 flies but none fed.

(4) A very young specimen of another species of MURIDAE was placed in the jar with four flies. The animal, which was reconciled to captivity, became very agitated, attempting to burrow and squeaking loudly ; when the flies went near the head they were caught and mauled ; the following day one was still alive but had not fed.

(5) A young wild mouse was placed in the jar with five flies. All were caught and eaten in a few minutes.

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* [Mr. F. W. Fiske has already pointed out (Bull. Ent. Res. iv, p. 103) that the results of laboratory experiments upon the food value of reptilian blood should be accepted with some reserve, as they are not borne out by field observations. Dr. H. L. Duke and Dr. G. D. H. Carpenter have noted that *G. palpalis* feeds freely on monitor lizards, under natural conditions on the islands in Lake Victoria, and as a result of his own recent observations in the same locality Mr. Fiske concludes that these lizards constitute the most favoured food of that fly.—ED.]

(6) A mole rat (*Georychus*), a burrowing rodent with inconspicuous eyes, no pinnae and protuding incisors, was placed in the jar with ten flies. The animal showed violent agitation, but owing to its sluggish movements had difficulty in catching the flies; at the end of an hour two had fed well and six had been killed. In repetitions of the experiment thirteen more flies were used of which five succeeded in feeding.

(7) A species of dormouse was placed in the jar with five flies; several of the flies attempted to feed, but all were caught and eaten. The experiment was repeated twice with the same result.

(8) Five flies were placed with a shrew (*Crocidura* sp.) and were all quickly caught and eaten.

(9) A young banded mongoose (*Crossarchus* sp.) was placed in the jar with ten flies. One fly settled on the back and commenced to feed, but was at once scratched off and eaten; the others were quickly caught and devoured.

B. With birds.

(10) Only one experiment was carried out with a bird. A fowl was placed in a large cage (36 in. by 18 in. by 18 in.) and 20 flies were introduced. The fowl was well supplied with food, but by the following morning all the flies had been eaten.

C. With reptiles.

(11) A skink lizard, five inches in length was placed in a fly tube with three flies. All attempted to feed and one fed full. By the following morning two had been eaten and the other was eaten later.

(12) Three flies were placed in a fly tube with a young gecko. On the following day one had fed. The others did not feed during the two following days. The lizard which was very small did not attempt to catch them.

(13) A chameleon was placed in the jar with ten flies, two of which fed at once, while others attempted to do so; all were eaten later. Four repetitions of the experiment gave similar results.

D. With Amphibia.

(14) Experiments were carried out with two species of toad and 45 flies. In each case the flies became quickly incapacitated by the skin secretions and urine which was splashed about the jar. Both toads showed extreme irritation at the presence of the flies.

The conditions under which the experiments were carried out were very artificial, the animals, and still more the flies, being eager to escape. It is apparent however that the tsetse is willing to feed on the smaller animals. On the more active ones it would have little chance of obtaining a meal when they are alert. Many of the small mammals are nocturnal and spend their days sleeping in hiding places which are the same in many cases as those which the tsetse haunts. This applies also to many of the nocturnal birds. It is a very common experience to see tsetses fly out of a burrow in the ground or a hollow in a tree, while the numbers of pupae which are taken in such positions show that they are much frequented by the female flies. When asleep, such animals would probably form a ready prey to the fly, as is the case with man and the mosquito. When awake, man rarely allows mosquitos to feed full upon him, but it is a common occurrence to find them fully fed inside a mosquito curtain in the morning. It is therefore possible that these small animals supply a larger proportion of the food of the tsetse-fly than is generally supposed.

Game destruction.

In view of such facts, it is not certain that the diminution of the fly at the time of the rinderpest was due to a reduction of its food supply.* No records of the climatic conditions at that time are available. It is known that both high and low temperatures have a considerable influence on the tsetse-fly and from these or some other causes its diminution at the time of the rinderpest may have been merely a coincidence. The evidence is not sufficiently definite to warrant the extermination of the larger mammals. The first effect of such a course would undoubtedly be that man would be more subject to the attacks of the fly.

Further evidence of the relation of the fly to the larger mammals could be obtained by compelling it, under as natural conditions as possible, to attempt to support itself on a diet of the smaller mammals, birds and reptiles. The following experiment is therefore suggested. A large fly-proof cage, of some such dimensions as 100 yards long by 50 yards wide and 7 feet high, would be constructed on a piece of country favoured by tsetse-fly and in which breeding places were known to exist. Into this cage would be introduced a number of small mammals and birds, the insectivorous species being excluded. A large number of tsetse would then be set free in the cage and daily observations as to their increase or decrease would be made by a well-veiled observer. At the end of twelve months it should be known if the fly is able to continue its species on such a fauna. In this event, increase should occur, since there would be few enemies in the cage. If the numbers of the fly decreased, the experiment would be repeated with the introduction of a few young antelopes, goats or sheep into the cage and similar observations would be made over the same period. If the increase occurred under these new conditions the dependence of the fly on the larger mammals would be made clear. The first of these experiments would also yield evidence as to whether the smaller mammals could act as the reservoir of the pathogenic trypanosomes of man and domestic stock.

Distribution of Breeding Places.

Searches for the pupae in nature have resulted in the finding of 735 living pupae and 1500 empty cases in 189 positions. A summary of these gives the following results :—

(*a*) In 40 instances the pupae were found in hollows in trees, 75 pupae and 350 cases being taken. The hollows are at varying heights from the ground up to six feet and are sometimes filled with very hard clay and sometimes with soft soil, dead leaves, the droppings of insects and the stomach-castings of birds. When the surface is hard the living pupae are found in crevices or quite exposed on the surface.

(*b*) In 30 instances pupae were found below trees or branches which slope at an angle or run parallel to the ground before rising. In such positions 129 pupae and 197 cases were taken. The ground was usually very hard and the pupae were taken on or near the surface or in cracks.

(*c*) Beneath fallen dead trees or branches 100 positions yielded 493 pupae and 759 cases; these include the most important breeding places. In such places accumulations of dead leaves and twigs usually occur and the pupae are found among these. When they are absent, the effort to burrow is great and pupae have been taken at a distance of 18 inches from the shelter of the tree. The trunks were often raised one or two feet above the ground, so that there was ample room for any insectivorous animal to search beneath them.

* Stevenson Hamilton, Bull. Ent. Res., ii, pp. 113–118. (1911.)

(*d*) Pupae were found in six instances in the chambers of termite nests in rotten upright stumps; 19 pupae and 61 cases were found in these positions. In several cases the termites were still living in the nests.

(*e*) In ten instances they were found in the burrows of various animals, 14 pupae and 99 cases being taken. These are usually the holes of bushpig or wart-hog, but pupae have also been found in smaller burrows.

(*f*) Pupae were taken three times in the hollows in old termite mounds excavated by the large mammals for the sake of the salt; five pupae and one case were found in these.

The larvae are thus not always dropped in places where they can hide in the earth or under débris, nor are they always placed in positions where scratching animals could not find them. It is a common feature to find the pupae in places where they are daily warmed by the sun for some hours. This shortens the pupation period, which is dependent on temperature. The one feature which is common to all the breeding places found is that above them there is always some relatively dark spot in which the female fly may rest concealed during pregnancy. It is believed that this, rather than any care for the offspring, is what guides the mother fly in the selection of breeding spots.

Special attention has been given to an area of about two square miles (see Map) close to the camp, which has been repeatedly and systematically searched for pupae. This area is bounded to the south and east by the Kalamba, a small stream which rises in a short-grassed swampy plain. As the plain narrows and its sides become steeper the grass becomes long, and it is at this point that the area under consideration commences. The banks of the stream then become steep and for a mile and a half it flows through a dense narrow swampy wood, such as is known in this district as "musitu"; its nature will be gathered from the photographs (Pl: x, fig. 1). Beyond this the stream becomes an open swamp till it joins the Kanchibia River a mile further on. The remainder of the area is a mixed open wood with little undergrowth and scanty grass, with a few open spaces due to outcrops of ironstone. Two native paths traverse the area and there is a well defined game path running near the stream. There are also short fragmentary game paths leading to the fords and drinking places, six of which exist and are the only parts of the musitu where water is accessible. In one part a number of old termite mounds, evidently rich in salt, are a great attraction to the game animals. Large animals are numerous in the area, rhinoceros, bushpig, warthog, zebra, eland, hartebeeste, waterbuck, roan and duiker being resident or entering it fairly regularly.

In this area 174 breeding places have been found and mapped out in relation to the paths and stream. Of these, 123 yielded less than ten pupae each, 404 in all, an average of 3·25 per position; these positions will be seen from the map to be scattered generally through the bush with no special relation to the paths. From ten to 50 pupae each were obtained from 38 breeding places, 831 pupae in all, an average of 22 per position; these positions are all within 150 yards of a native or game path with the exception of four which yielded 10, 13, 20 and 32 pupae respectively and which are in close relation to the salt-licks. Over 50 and under 150 pupae were found in 13 positions which yielded 892 pupae, an average of 68·5 per position; these positions

bear a very close relation to the paths, nine of them being within a yard, and the remaining four being less than 100 yards from a path.

It has been repeatedly noticed that the farther from a path the search is conducted the fewer are the pupae found, though suitable places may be just as numerous. An instance of this is seen by comparing Pl. x, fig. 2, and Pl. xi, fig. 1. The accumulation of dead branches shown in the former photograph is 300 yards from a path and forms an apparently ideal position for pupae; when searched only six empty cases were found. The latter figure shows a similar accumulation which is close to the junction of two paths and a ford; this yielded 19 living pupae and five cases. Two thin prone dead trunks situated about 100 yards from a path yielded 24 pupae and 59 cases, while in a precisely similar position 150 yards further from the path only three empty cases were found. A number of similar instances could be given.

It is not supposed that nearly all the breeding places in the area have been discovered, as quite a small dead branch may shelter a number of pupae. Those found however are probably representative of the whole and it is possible from these data to deduce with some degree of certainty the movements of the female flies. When the female fly has fed, it apparently leaves its host and seeks the nearest suitable hiding place, where the food is digested. In these places also the larvae are dropped. Since the movements of the game from water to feeding grounds are usually along definite routes the advantages to the fly of being near these routes must be very great when it requires another meal. The advantages to the newly emerged fly would be greater still, since the insect requires food on the day after emergence under warm conditions and in the colder months dies if it cannot obtain food during the first three or four days of its life. If the fly emerged at a great distance from the path it might have to wait a very long time for an animal to pass, while near these tracks daily opportunities of feeding would be given, since the native paths are much used by game animals.

The Breeding Season.

Evidence has been obtained that in this district breeding is almost confined to the warmer part of the dry season. The searches were conducted from December to the end of August, rain falling during the first six of these months. Positions in which pupae had been found in some numbers during the previous dry season were regularly examined. In 21 searches rom December to the end of June only two living pupae were found, these being taken at the end of January. In seven searches during the latter half of July 44 living pupae were taken. In four searches at the beginning of August 120 pupae were collected; while six searches at the end of the same month yielded 486 pupae. Had the searches in June been more protracted a few pupae would probably have been found, since flies emerged during August from 27 of the pupae collected. These had probably been deposited towards the end of June or very early in July.

Under two trees which had been felled by lightning during the early part of the rainy season, pupae were found in August. The first of these was a tall tree from three to 12 inches in diameter (Pl. xi, fig. 2) which fell across the game path close to a ford. This spot was almost daily visited by rhinoceros and warthog which wallowed in the mud and then cleaned themselves against the fallen trunk. On 18th August, 68 living pupae and five empty cases were collected under the trunk. The empty cases

were from pupae which had probably been deposited before the end of June. The position was again examined a week later and 22 more living pupae were taken. No flies emerged from these 90 pupae before the end of August, and as they were in such a position that they would have received much benefit from the sun, it is not likely that they would have remained as pupae for more than 60 days. (The pupation period is 62 days at a temperature of 65° F. The mean temperature in the laboratory during this period was 62°, but that to which the pupae were exposed would be higher for the reason given).

The second position was under the trunk and branches of a large tree which was broken off six feet from the ground, the broken ends remaining connected. The tree was lying close to the salt-licks. Under this 27 pupae and no empty cases were collected on 22nd August. No flies emerged from these before the end of August.

In Table V the numbers of pupae and cases taken in positions which were searched on several occasions are given. In these places pupae were found in increasing numbers during July and August as the weather became warmer. The empty cases which were collected in April were found by deeper excavations and were of old date. As the work was discontinued owing to the abandonment of the Ngoa camp at the end of August, no data are available as to what obtained during the remaining months of the dry season. It is probable however that active breeding would continue through September and October until the commencement of the rains, as the climatic conditions are much the same as in August, the plateau country being never subject to the intense heat of the Luangwa Valley and other low-lying parts.

TABLE V.

Showing Evidence of the Breeding Season of G. morsitans.

Description of position.	Dates of searches and numbers of pupae (p) and empty cases (c) found.					
1. In small hollow in tree trunk (Pl. xii, fig. 1.)	29. vii. 12. p. 10, c. 9.	5. i. 13. p. 0, c. 12.	28. iv. 13. p. 0, c. 28.	30. vii. 13. p. 6, c. 3.	28. viii. 13. p. 5, c. 0.	25, viii. 13. p. 5, c. 0.
2. Large hollow in tree trunk.	" p. 1, c. 50.	" p. 0, c. 15.	" p. 0, c. 47.	1. viii. 13. p. 1, c. 16.	" p. 4, c. 2.	" p. 5, c. 0.
3. Under slightly raised living trunk (Pl. xii, fig. 1.)	" p. 1, c. 1.	" p. 0, c. 6.	" p. 0, c. 35.	31. vii. 13. p. 3, c. 1.	19. viii. 13. p. 7, c. 0.	
4. At the bases of two sloping trunks (Pl. xii, fig. 1.)			24. iv. 13. p. 0, c. 15.	30. vii. 13. p. 7, c. 2.	18. viii. 13. p. 17, c. 1.	" p. 13, c. 0.
5. Under dead trunk.				28. vii. 13, p. 1, c. 45.	" p. 2, c. 2.	" p. 18, c. 2.
6. Under dead trunk and branches.				1. viii. 13. p. 4, c. 28.	" p. 4, c. 2.	" p. 22, c. 0.

Summary and Conclusions.

1. *G. morsitans* is willing to feed on small mammals, birds and reptiles; its ability to do so depends on their agility. As it haunts the sleeping places of many of these it probably feeds on them to some extent when they sleep.
2. Reptilian blood is not suitable to *G. morsitans* as a continued diet. Mammalian blood has a slight advantage over avian as a diet, and this is shown by the larger average size of the pupae produced in the laboratory.
3. Some experiment is necessary to determine finally the relation of *G. morsitans* to the larger mammals. This could be carried out in a large fly-proof cage.
4. The one feature common to the breeding places found is that in close proximity to each there is some relatively dark place where the mother fly can hide during pregnancy.
5. Pupae are deposited in much larger numbers close to places where large mammals are certain to pass frequently (*e.g.*, paths, native and game, fords, drinking places) than in places in the general bush.
6. On the high plateau of Northern Rhodesia *G. morsitans* begins to breed freely about the second month of the dry season (July) and almost or entirely ceases to do so in the rainy season.

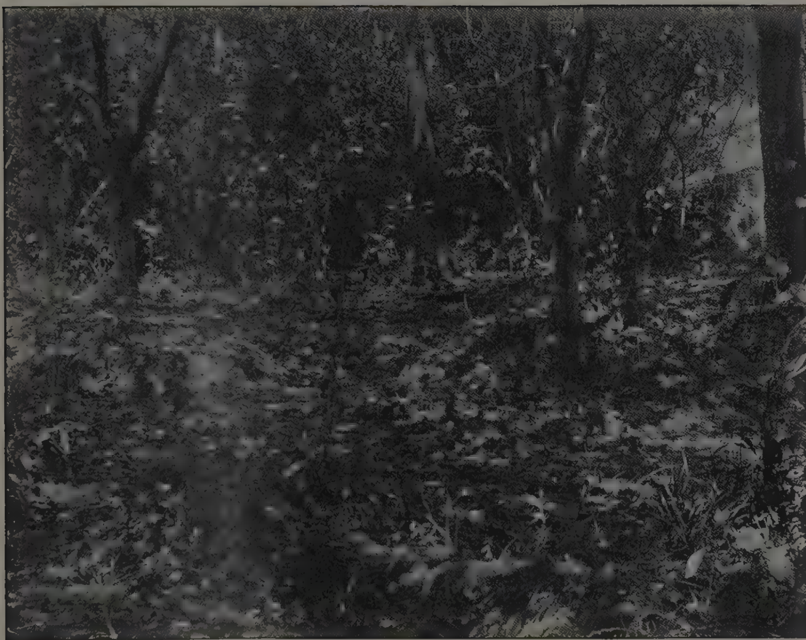

Fig. 1. Ford across a small stream, close to position No. 120, where Pig and Rhinoceros wallow; the dense bush in the background is continuous for 1½ miles, except for places similar to this.

Fig. 2. Position No. 155, 300 yards from a path; yielded no pupæ and 6 empty cases.

Fig. 1. Position No. 133, 10 yards from path and 20 yards from the wallow (Pl. X. fig. 1); yielded 19 living pupæ and 5 empty cases.

Fig. 2. Position No. 120, close to the wallow; searches, on two days only, yielded 90 living pupæ and 5 empty cases.

Fig. 1. Position No. 3, in hollow in tree on the left, yielded 26 pupæ and 52 empty cases. Position No. 27, in soil in angle between the two sloping trees on the right, yielded 37 pupæ and 18 cases; close to path and wallow.

Fig. 2. Position No. 8, very close to path (in foreground), yielded 11 pupæ and 43 cases.

Fig. 1. Position No. 158, under overhanging ends of log, 100 yards from path, yielded 22 pupæ and 35 cases.

Fig. 2. Fence round a Kafir garden; 12 living pupæ found at short intervals along the bottom of the fence.

PLAN OF AN AREA IN WHICH *G. MORSITANS* BREEDS, SHOWING THE DISTRIBUTION OF BREEDING PLACES IN RELATION TO PATHS, ETC.

TWO PESTS OF MAHOGANY IN NYASALAND.

By E. Ballard.

Government Entomologist, Nyasaland Protectorate.

Mahogany trees are attacked by two caterpillars which inflict a large amount of damage every year. One of these, *Heteronygmia leucogyna*, Hmp. (Lymantriidae), eats the leaves, while the other, *Mussidia albipartalis*, Hmp. (Pyralidae), bores under the bark, causing much deformity of young trees and the formation of corky excrescences, accompanied by the exudation of resin.

The main points of the life-history of *Heteronygmia leucogyna* are as follows. Between 150 and 200 eggs are laid in a single batch, generally low down on the trunk of the tree. These eggs are, when first laid, of a milky-white colour, smooth and spherical, with slightly flattened upper pole. Just before they hatch they become dark owing to the presence of the contained embryo. After about nine days, the young larvae emerge, through the top of egg. When just hatched they measure 3 mm. in length, and are pale yellow in colour, with bunches of fine hairs. The full grown larvae vary slightly in colour, some being very pale, while others are darker, with dark heads. All the larvae have a very flattened appearance, and are marked dorsally with black and red. The length of the full-grown larvae is 3 cm. The pupa is formed in a very slight cocoon consisting of a few threads, generally on the under side of a leaf, or on an excrescence on the bark. The colour of the pupa varies from green to brown. The pupation period lasts for ten days.

Both the larvae and eggs of *H. leucogyna* are heavily parasitised. Two species of Chalcididae, and one Ichneumon, *Ecthromorpha variegata*, Brullé, have been bred from the larvae. During May and June nearly 90 per cent. of eggs collected were found to be parasitised, but those collected during September and October were unaffected.

The larvae of *H. leucogyna* are extremely voracious, and last rainy season practically defoliated the mahogany plantation in the Bwaila Gardens, near Zomba. They were also extremely destructive to the trees shading one of the roads in Zomba township.

The bark-borer of mahogany is the larva of *Mussidia albipartalis*, Hmp. It is most destructive and disfiguring to mahogany trees. Young trees which are attacked by this insect are contorted and twisted, and the growth of the main stem is frequently arrested. Large excrescences are formed at the point of attack, and in some cases the entire trunk of the tree is gnarled and roughened, and drips with resin as the result of the activities of these insects. On well-grown trees their depredations are confined to the cambium, but in young trees and small twigs they often bore right down the middle after the manner of a Cerambycid or other wood-boring larva. When climbing plants, such as the chitedze bean are twined round the stem of a tree infested with *Mussidia* the larvae work spirally round the tree under the stem of the climber, and they generally appear to show a predilection for working where there is something pressing against the tree trunk, or where branches fork.

The life-history has been only partially elucidated. The eggs are apparently laid on the trunk. The young larva on hatching begins to bore into the bark at once. The full grown larva is about one inch in length, and is coloured blue-grey, or grey-

green, with a broad lateral " flush " of either salmon pink or terracotta. This colouring is much more noticeable in the young larvae, which appear to be uniformly reddish or pink, but in full-grown larvae the colour is much fainter and scarcely more than a " flush," as stated above. On each segment are four conspicuous black tubercles on each side, and two more latero-ventrally. The thoracic shield is black and the head may be black or brown. The pupa is formed in a cocoon of tough white silk, and placed under the rough excrescences produced by the borings of the larva. The pupation period during the cold weather is a month, in the hot weather the time is reduced.

This very troublesome insect is parasitised by an Ichneumon and a Chalcid ; but they do not seem to afford a very efficient check, judging from the amount of damage done.

NEW SPECIES OF CULICIDAE IN THE BRITISH MUSEUM, WITH NOTES ON THE GENITALIA OF SOME AFRICAN CULEX.

By F. W. Edwards.

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In preparing his first synopsis of the African species of *Culex* (Bull. Ent. Res., ii, pt. 3, Oct. 1911) the writer relied almost entirely upon characters of coloration for the separation of species, and had made no study of the male genital organs ; at the same time it was pointed out that the group of species allied to *Culex invidiosus* required much additional study before their classification could be regarded as satisfactory. It is now possible to give in full the results of further study of the African species of *Culex* of the *pipiens* and *invidiosus* groups. It has been found that, in these groups at least, the species can most readily be separated by means of the male genitalia, and also that one or two names which had previously been sunk as synonyms must in reality stand as good species. In the present contribution figures are given of the male genital organs of eleven species ; these, together with the four already illustrated (Bull. Ent. Res., iv, pt. 1, May 1913) comprise all the African *Culex* with the exception of (1) those with a banded proboscis ; (2) those with characteristic leg markings, *C. tigripes* and *C. tipuliformis* ; (3) *C. pruina*, which is described below ; (4) *C. didieri*, N.L., and *C. pygmaeus*, N.L., which the writer is unable to recognise ; and (5) those with the pale markings of the abdomen situated towards the apices of the segments. As before, all the figures have been prepared by Mr. A. J. Engel Terzi with very great care and accuracy, and I am much indebted to him for his assistance in this difficult piece of work.

The male hypopygium of *Culex* may be described as follows :—The word *hypopygium* is used to denote all the structures representing the ninth and tenth segments of the abdomen. The ninth segment is typically represented by a small tergite and sternite and a pair of large side-pieces carrying the claspers at their ends. In *Culex* the ninth tergite is usually about twice as broad as long, the only exception known to me occurring in *C. perfidiosus* (fig. 12) in which this plate is distinctly longer than it is broad. The sternite, as in most other Culicidae, is represented by a pair of narrow plates just connected in the middle and furnished on their posterior margin with a fringe of hairs ; these lobes have been variously termed the setaceous lobes and the basal appendages ; they are incorrectly regarded by Felt, Theobald, Howard, Dyar and Knab as belonging to the eighth abdominal segment. The side-pieces are very hairy, but without scales ; they have processes on their inner side near the apex which bear a leaf-like plate and five or six usually more or less rod-like filaments. The tenth body-segment is represented in the simplest forms of *Culex* by three sets of paired

organs, the unci, harpagones and harpes. The unci (fig. 1, *a*) are the most dorsally

Fig. 1.—*Culex trifilatus*, sp. n.

Basal parts of hypopygium from above, highly magnified ; right side-piece of hypopygium, inner side view, enlargement about half that of the basal parts ; *a*, unci ; *b*, first, *b*¹, supplementary and *c*, second divisions of the harpagones ; *d*, harpes, with crowns of spines ; *e*, basal projection of the harpes.

situated ; they have practically the same form throughout the genus, and are usually very strongly chitinised. These plates are regarded by Dyar and Knab as representing a division of the harpagones, but I believe this view to be incorrect, and prefer to consider them as strictly homologous with the unci of other Culicidae. The harpagones in the simplest forms of the *Culex* group (*Culiciomyia*, etc.) are represented by a single pair of undivided plates, but in all the forms here considered they have a more complex structure, consisting of at least two definite divisions, the first one often elaborately split up, the second one usually taking the form of a long straight rod just above the harpes. In some species (as *C. pipiens*, *C. fatigans*, *C. trifilatus*) the first division of the harpagones is clearly divided into two portions, in which case the lower part is here spoken of as the supplementary division (fig. 1, *b*¹). The harpes are provided with a dense crown of spines, and normally they have a long finger-like projection at their base.

Normally the small basal parts of the hypopygium (unci, harpagones and harpes) are in the relative positions in which they are shown in this paper, but sometimes (perhaps after use) they take up another position relatively to one another, in which the unci are folded outwards and the harpagones pushed out so that they occupy a position at right angles to the normal one. The figure of *C. pallidocephalus* (Bull. Ent. Res., May 1913, p. 56) represents these parts in this position; a specimen in which they are thus placed (and the dislocation may occur in any species of *Culex*) at first sight appears to possess a very different structure from one in which the position is normal.

Culex trifilatus, sp. nov.

Head with the upright forked scales yellow, a few black towards the sides; narrow curved scales yellowish-white; orbital bristles black, except those in the middle, which are yellow. Palpi and proboscis in the female entirely black-scaled. Male palpi longer than the proboscis by the last joint; penultimate joint with a line of yellowish-white scales beneath, terminal joint with two or three similarly coloured scales at its base beneath. *Thorax* with dark brown integument, black bristles and small dull bronzy-brown scales, mixed with slightly paler and coarser ones which tend to form indistinct lines; the scales on and near the scutellum yellowish. *Abdomen* black dorsally, with well-defined yellowish basal bands on each segment, of almost even width, but broadening out laterally into the usual side-spots which are not visible from above. Segments of venter with black apical bands, which in the middle line extend nearly to the base of each segment. *Hypopygium* of ♂ as in fig. 1. The specific name is derived from the three filament-like divisions of the harpagones, which readily distinguish this species from all others. *Legs* black-scaled, except the under sides of the femora towards the base, and the tips of the femora and tibiae which are yellowish. Claws normal (*i.e.* the fore and mid claws of the male unequal, each with a single tooth, the hind claws of the male and all the claws of the female equal and simple). *Wings* with dark brown scales; the fork-cells rather long, the upper one with its base a little nearer to the base of the wing; cross-veins separated by a distance rather less than the length of the posterior one. Lateral vein-scales linear.

Length about 5 mm.

British East Africa: 18 ♂ (including type) 31 ♀, Kabete, xi. 1913 (*T. J. Anderson*).

This species closely resembles *C. pallidocephalus*, Theo. It differs in having more numerous yellow upright forked scales on the head (in *C. pallidocephalus* most of these scales are brown) and in the slightly shorter male palpi, which have no white scales towards the apex of the terminal joint on the under side; the dark apical bands on the ventral segments are more distinct and blacker than in *C. pallidocephalus*. In *C. pallidocephalus* there are some paler scales on the under side of the proboscis about the middle, especially in the female; there are quite absent in *C. trifilatus*. Also the ventral aspects of the femora in *C. pallidocephalus* are much more extensively pale.

Culex andersoni, sp. nov.

Differs from *C. trifilatus* as follows:—the narrow curved scales of the head are more golden-yellow, and the brown upright forked scales preponderate over the yellow ones; the scales of the mesonotum are mainly golden-yellow, with a certain number of

dark brown ones, most numerous on the posterior third, where the golden yellow ones tend to form two distinct lines, one on each side of the bare space in front of the scutellum; scutellar scales golden yellow; under sides of femora almost entirely dark; hypopygium as in fig. 2.

Length about 6 mm.

BRITISH EAST AFRICA: 6 ♂ (including type) 12 ♀, Kabete, 2. viii. 1913 (*T. J. Anderson*); bred from larvae found in a bucket of rain-water on the Government Farm.

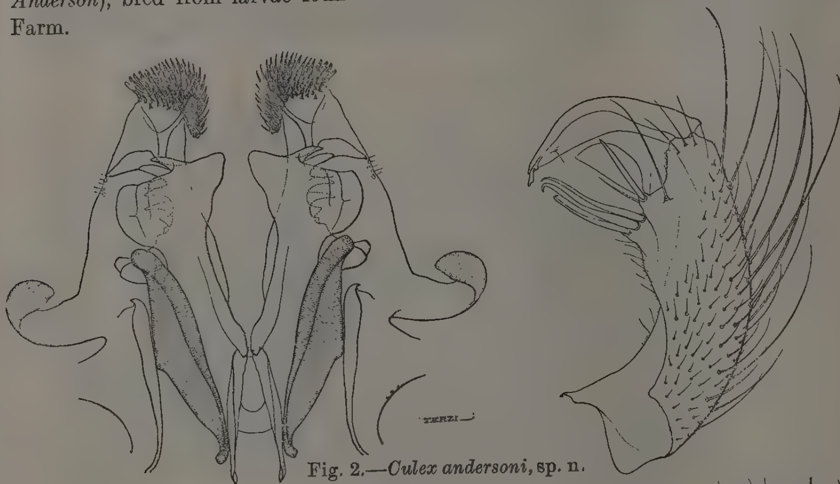


Fig. 2.—*Culex andersoni*, sp. n.

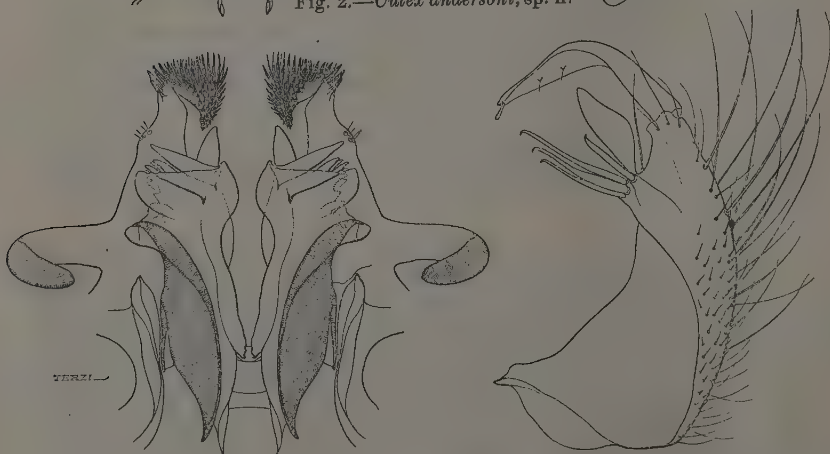


Fig. 3.—*Culex simpsoni*, Theo.

Larva whitish, with very dark head and siphon. Head tufts composed of 4–6 plumose hairs, the two pairs in the middle very close together. Tuft of antenna at about $\frac{3}{5}$. Comb of eighth segment consisting of a patch of about 60 scales, roughly equal in size. Siphon about 5×1, pecten consisting of about 15 teeth, reaching nearly half the length of the siphon; three pairs of ventral hair-tufts and one lateral pair at about $\frac{4}{5}$.

Culex simpsoni, Theo.

Although this species has really little resemblance to *C. andersoni* the hypopygia of the two are very similar, the chief differences being that in *C. simpsoni* (fig. 3) the unci are more sharply pointed and the first division of the harpagones is differently toothed. *Culex simpsoni* is much smaller than any of the members of the *pallidocephalus* group (*pallidocephalus, mirificus, trifilatus, andersoni*) and has the cross-veins more widely separated.

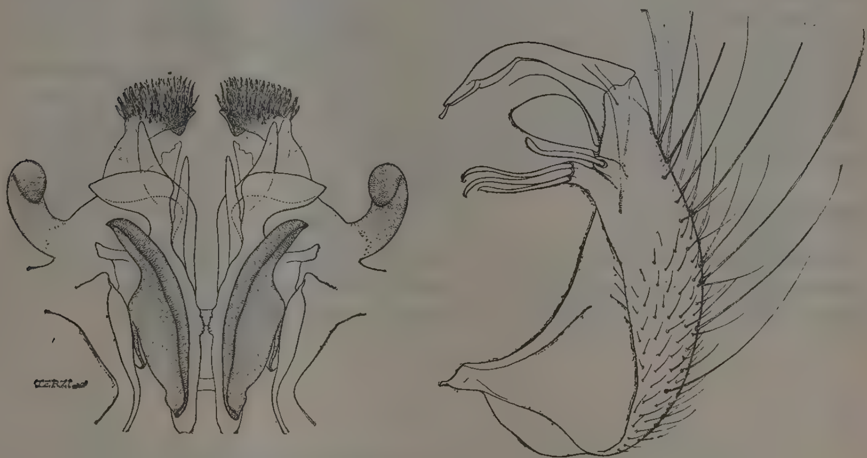


Fig. 4.—*Culex neavei*, Theo.

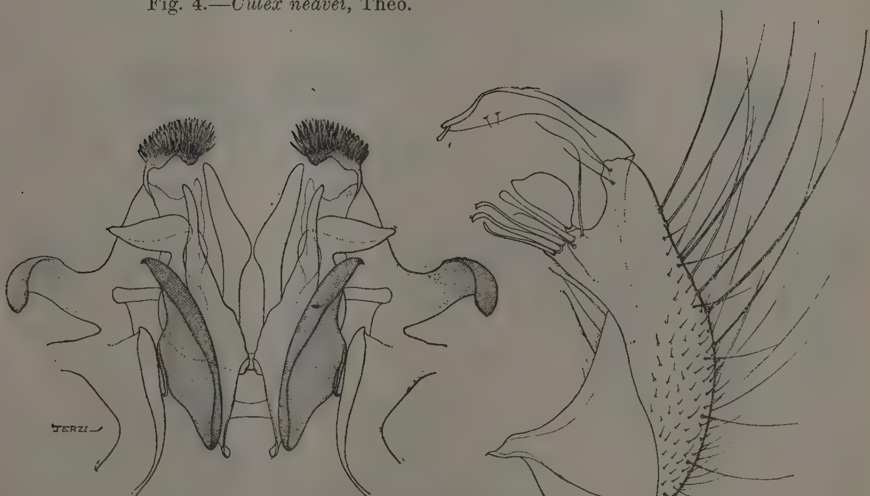


Fig. 5.—*Culex univittatus*, Theo.

Culex neavei, Theo.

This was previously sunk by the writer as synonymous with *C. guiarti*, Blanch., but it now appears that the two must be kept separate, although no tangible

external characters can be adduced for their separation. The hypopygium of *C. neavei* (fig. 4) is all but identical with that of *C. univittatus* (shown for comparison with *C. neavei* and *C. simpsoni* in fig. 5). *C. neavei* can hardly be a variety of *C. univittatus*, as the hind tibiae are altogether devoid of the white lateral stripe and have scarcely a trace of a pale spot at the apex.

A more careful examination of the type male of *C. quasiguiarti* reveals the fact that it is really a specimen of *C. neavei* and not of *C. pallidocephalus*, as was previously suggested (Bull. Ent. Res., iv, p. 56), and also that the male and female types of *C. quasiguiarti* probably do belong to the same species. The abdomen is not really banded, although it is rubbed in such a way as to appear so. The name *quasiguiarti* must therefore fall as a synonym of *C. neavei* and not of *C. pipiens* or *C. pallidocephalus*. Single male specimens of *C. neavei* are in the British Museum collection from Kampala Swamp, Uganda (*Capt. A. D. Fraser*) and Kisumu, British East Africa (*Dr. A. Mouat*).

Culex guiarti, Blanch.

The hypopygium of the type male of this species is too damaged for purposes of illustration, and the figure (fig. 6) has therefore been made from a specimen from Nairobi (*Dr. C. W. Daniels*) which was first carefully compared with the type.

Fig. 6.—*Culex guiarti*, Blanch.

It was found on examination that the West African *C. grahami*, Theo. has a hypopygium extremely similar to that of *C. guiarti*, and as the two are very much alike in external characters, it seems best to regard them as merely geographical forms of the

same species. *C. guiarti* var. *grahami* (fig. 7) differs from the type in having the unci rounded at the tip, no basal prominence on the first division of the harpagones,

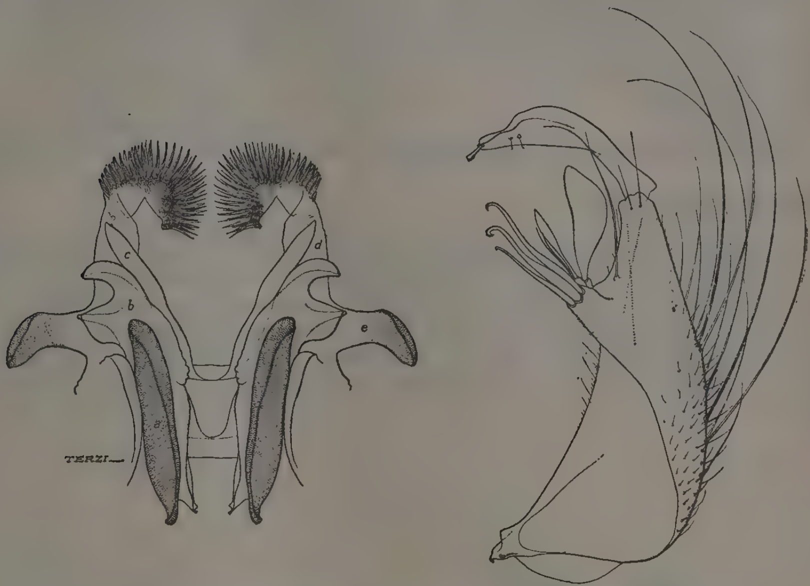


Fig. 7.—*Culex guiarti*, Blanch., var. *grahami*, Theo. ; from Graham's type of *C. pullatus* ; lettering as for *C. trifilatus* (fig. 1).

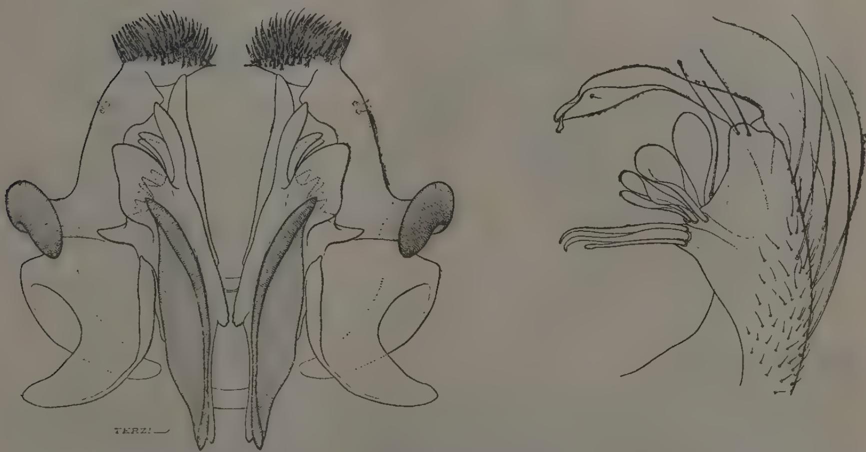


Fig. 8.—*Culex trifoliatus*, sp. n.

more numerous spines in the crown of the harpes, and a shorter basal projection. The fork-cells also seem to be rather longer in the West African form, which has a fairly distinct whitish tip to the hind tibia, which the type form has not.

Culex trifoliatus, sp. nov.

Closely resembles *C. guiarti*, Blanch., var. *grahami*, Theo., but differs in the hypopygium: two of the usually filamentous processes of the side-pieces have become broad and flattened, so that the side-piece appears to have three leaf-like plates; the unci are pointed and the first division of the harpagones is much more elaborately toothed than in *C. guiarti*.

UGANDA: 2 ♂ (including type) 1♀, Kasala, i. 1911 (*Capt. A. D. Fraser, R.A.M.C.*).

Culex invidiosus, Theo.

As previously stated, I can detect no difference whatever between the hypopygia of this species and of *C. decens*. The hypopygium of *C. ornatothoracis*, Theo., is also identical, and as this form only differs from *C. invidiosus* in the aggregation of the paler scales of the thorax into two more or less definite spots, there can be little doubt that the two are conspecific. The true *C. invidiosus* is probably a purely West African species. The hypopygium (fig. 9) is illustrated for comparison with the three following species.

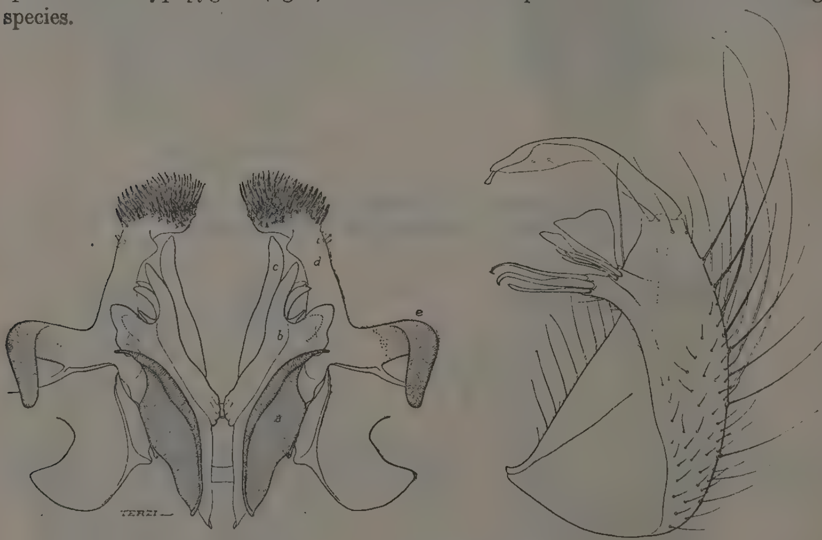


Fig. 9.—*Culex invidiosus*, Theo.

Culex laurenti, Newst.

Through the kindness of Prof. R. Newstead and Mr. H. F. Carter of the Liverpool School of Tropical Medicine, I have been able to examine the hypopygium of the type of this species (see fig. 10). It proves to be distinct from *C. guiarti* and the name must therefore be resuscitated. The basal projections of the harpes are broader than in any of the other species here illustrated, and the first division of the harpagones is differently toothed, the second being well developed, thus distinguishing it from *C. perfuscus*, which it otherwise somewhat resembles. The species is only known to

me from the type specimen, and unfortunately no definite external characters can be given to distinguish it from *C. guiarti*, except that it appears smaller and the thorax has a more reddish tinge.

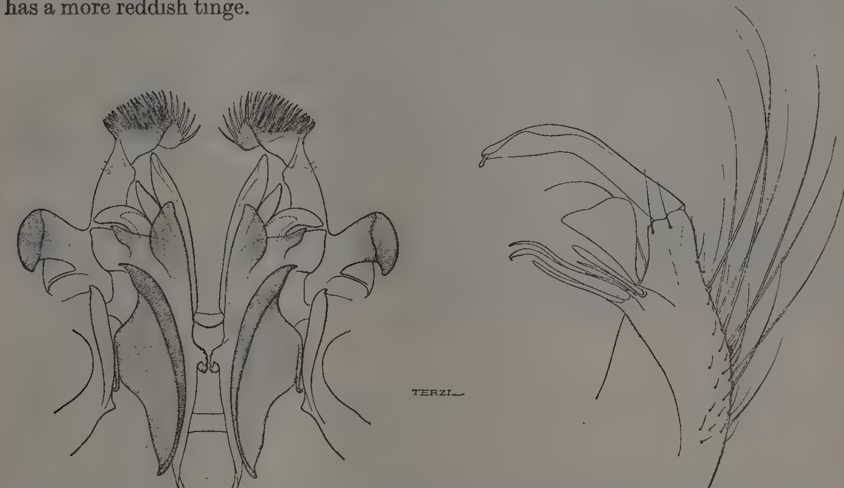


Fig. 10.—*Culex laurenti*, Newst.

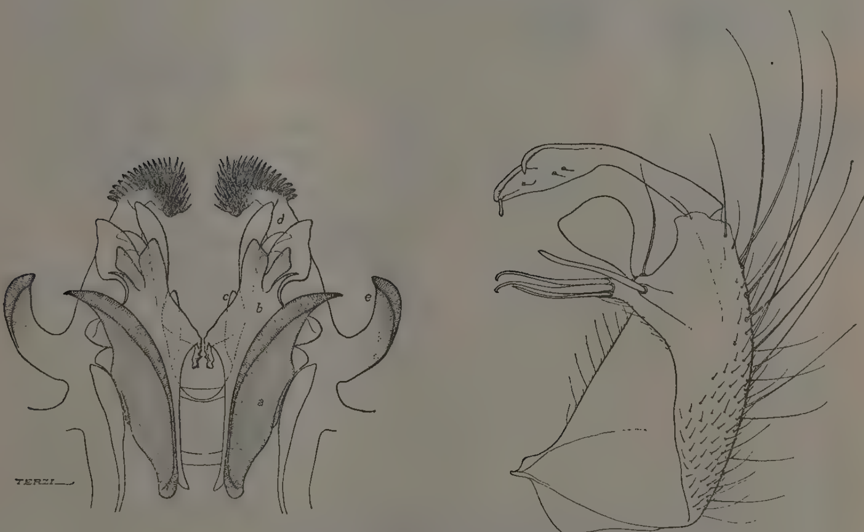


Fig. 11.—*Culex perfuscus*, sp. n.;
Lettering as for *C. trifilatus* (fig. 1); note the much divided first and rudimentary second divisions of the harpagones.

Culex perfuscus, sp. nov.

A blackish species, closely resembling *C. invidiosus*, but darker; the hind tibiae without any trace of a pale spot at the apex, which in *C. invidiosus* is usually (but apparently not invariably) present.

The hypopygium (fig. 11) is readily distinguishable from that of *C. invidiosus* as follows: the clasper has a rounded prominence near its tip; the second division of the harpagones is rudimentary, being represented by a mere knob, and the first division bears dorsally a strongly chitinised plate which is found only in this species and in *C. laurenti.*

NYASALAND: 52 ♂ (including type) 62 ♀, Port Herald, 2. iv. 1913, "invaded house" (*Dr. J. E. S. Old*); 1 ♀, Fort Johnston, xii. 1912 (*Dr. R. Bury*); 3 ♂, Mlanje, i. 1913 (*S. A. Neave*); 2 ♂ 1 ♀, Fort Maguire, 16. iii. 1910 (*Dr. A. H. Barclay*). BRITISH EAST AFRICA: 1 ♂ 1 ♀, Kabete, xi. 1913 (*T. J. Anderson*). NORTHERN NIGERIA: 1 ♂, Zungeru, 13. iii. 1911 (*Dr. J. W. Scott Macfie*).

Culex perfidiosus, sp. nov.

Resembles *C. invidiosus* so closely that no external distinguishing characters can be pointed out. The hypopygium however is utterly different (*cf.* figs. 9 and 12), particularly in the form of the ninth tergite and the structure of the side-pieces and

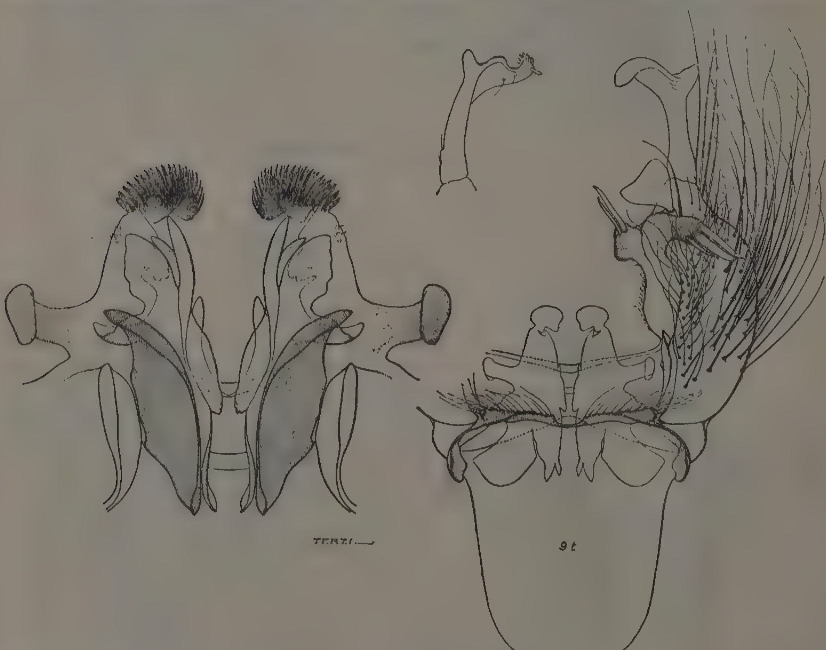


Fig. 12.—*Culex perfidiosus*, sp. n.

Basal parts of hypopygium greatly enlarged, from above; the whole organ less highly magnified, from beneath; a detached clasper in side view; 9t, the abnormally developed ninth tergite.

claspers. The ninth tergite is about three times as long as in any other species which I have examined, and the lateral processes of the side-pieces are very peculiar. The basal parts of the hypopygium much resemble those of *C. invidiosus*, but, as in *C. perfuscus*, the second division of the harpagones is rudimentary.

The specific name has been chosen to indicate the deceptive resemblance to *C. invidiosus* and *C. perfuscus*.

S. Nigeria : 1 ♂ (type), Ilesha, 15. ix. 1910, caught in house (*Dr. T. F. G. Mayer*); 1 ♂, Lagos, caught in bush, 10. ix. 1909 (*Dr. W. M. Graham*). N. Nigeria : 1 ♂ 2 ♀, Lokoja (*Dr. C. F. Watson*). Belgian Congo : 1 ♂, Yumbi, 30. vii. 1912 (*Dr. F. Mouchet*).

Culex pruina, Theo.

The hypopygium of this species (which is not illustrated) is very characteristic, on account of the short thick harpes, the basal projection of which is very broad and short, much broader than it is long. The harpagones are fairly simple in structure, and appear not to be split into two distinct divisions as in most of the species illustrated in this paper.

Culex pulchrithorax, nom. nov.

Pseudohowardina lineata, Theo., Entomologist, xlv, p. 92 (1912) ; *nec Culex lineatus*, v. Humboldt (1820).

An examination of the hypopygium of the single male specimen in the British Museum collection revealed the fact that in the structure of the side-pieces and harpes it closely resembles a typical *Culex*. This is most surprising as the thoracic ornamentation is so very different from that of all other known species of the genus. Unfortunately the specific name *lineatus* has already been used in *Culex*, so that now this species is transferred to its proper genus it requires renaming.

In addition to the five species of *Culex* just described as new, the following apparently new species (three and two varieties from the Ethiopian, eight from the Oriental Region) have at various times come to the writer's notice. The types of all are in the British Museum, and unless otherwise stated have been presented by the collectors.

Banksinella fuscinervis, sp. nov.

Head with narrow curved scales in the middle, mostly bright yellow, with a small patch of dark brown ones in front ; flat scales at the sides, mostly dark brown, but a small stripe of yellow ones in the middle of the dark patch. Basal joint of antennae orange-brown, rest dark brown. Scales of palpi and proboscis all dark brown ; male palpi longer than the proboscis by nearly the length of the second (last) joint, which is quite five times as long as the labella. *Thorax* dark brown, with narrow dark brown and yellow scales, the latter situated mostly round the margin, but not forming a definite yellow stripe as in *B. luteolateralis*. *Abdomen* dark brown above, each segment with lateral basal yellowish spots, those on segments 5–7 slightly expanded towards the middle of the segments and thus visible from above. Venter yellowish, with apical dark bands on each segment. Male genitalia almost exactly like those of *B. luteolateralis* (*vide* Carter, Ann. Trop. Med. vii, p. 583, Dec. 1913) but the claspers are not so much swollen in the middle. *Legs* entirely clothed with dark brown scales, except for the undersides of the femora. *Wings* with all the scales brown, no yellow

ones on any of the veins; lateral vein-scales towards the tip of the wing linear-lanceolate. Bases of fork-cells practically level.

Gold Coast: 2 ♂ (including type), Accra, 19. vi. 1908 and 2 ♀, Obuasi, 8. viii. 1907 and ii. x. 1907 (*Dr. W. M. Graham*).

Type presented by the Imperial Bureau of Entomology.

This species resembles *B. luteolateralis* in its entirely dark hind tibiae, but the absence of pale scales from the wings, amongst other differences, will readily distinguish it.

Culex aurantapex, sp. nov.

♀. *Head* clothed with black upright forked scales, and dark brown and golden narrow curved ones. Proboscis with a well-defined yellowish ring just beyond the middle, no yellow scales at the tip. Palpi mainly with dark scales, a few yellowish ones in the middle and at the tip. *Thorax* black above, clothed with black scales and bristles, a few golden scales scattered over the surface, most numerous on the scutellum. *Abdomen* with a few black scales on the first segment; segments 2–4 black-scaled (dorsally), with a few scattered orange scales; segments 5–8 almost entirely orange-scaled both above and below. *Legs*: femora and tibiae mainly black (except the under sides of the femora), with scattered yellowish scales; tarsi black, with narrow yellowish rings embracing both ends of the joints. *Wings* clothed with dark brown scales, a very few pale ones towards the base. Lateral vein-scales linear-lanceolate. Fork-cells long, the upper one with its base nearer the base of the wing than that of the lower. Cross-veins separated by about the length of the posterior one.

Length about 6 mm.

British East Africa: 1 ♀, Nairobi, 18. viii. 1912 (*T. J. Anderson*).

Type presented by the Imperial Bureau of Entomology.

It is quite possible that this is only a strikingly marked variety of *C. annulioris*, Theo., or *C. bitaeniorhynchus*, Giles (= *C. ager*), but the black thorax and the orange tip of the abdomen give it a very distinct appearance. Leicester's "*Taeniorhynchus*" *domesticus* from the Malay States has a very similar colouring, but has more numerous pale scales on the wings.

Leptosomatomyia fraseri, sp. nov.

♂. *Head* clothed with narrow curved and upright forked scales above, a few flat scales at the sides; all the scales pale yellow. Basal joint of antennae orange, without scales; second joint with a whorl of rather long blackish scales; all the joints of the flagellum (except the last two) have the usual whorl of long hairs just before the middle, and in addition a distinct tuft of shorter hairs at the apex on the inner side (a similar tuft occurs in *Uranotaenia*, *Orthopodomyia*, *Ficalbia* and some species of *Mimomyia*, but is more marked in this species than in any other which I have seen); last antennal joint shorter than the penultimate; whole antennae markedly shorter than the proboscis. Palpi scarcely half as long as the proboscis, thin, without hair tufts, clothed with dark purplish scales. Proboscis shorter than the abdomen, a little thinner at the apex than at the base; basal half with dark purplish scales gradually

shading into orange on the apical half. *Thorax* clothed with light yellow and brown narrow curved scales, the yellow ones forming a broad marginal and a narrow median line; scutellum with a few narrow yellow scales; pleurae with some patches of silvery-white scales. *Abdomen* long and thin, with dark purplish-black scales above, each segment with silvery-white lateral patches extending along the greater part of the segment from the base. Genitalia of simple structure, almost exactly like those of *Theobaldia*; harpagones not developed. *Legs* clothed with dark purplish scales, except the under sides of the fore and mid femora, the basal half of the hind femora, the under side of the base of all the tibiae, the outer apical half of the middle tibiae and the base of the first joint of the middle and hind tarsi; in all these positions the scales are creamy-yellow. Claws of fore and mid legs unequal, the larger one with a long tooth near the base; hind claws equal and simple. *Wings* with dark brown scales; the lateral vein-scales lanceolate; fork-cells a little longer than their stems, their bases practically level.

Length about 7 mm. (without proboscis).

UGANDA: 1 ♂ (type), Kasala Stream, viii. 1910 (*Captain A. D. Fraser, R.A.M.C.*); 1 ♂, Chagwe Forest, ix. 1910 (*Capt. Fraser*). SIERRA LEONE: 1 ♂, Daru (*Dr. J. C. Murphy*).

There is no other genus in which this species can be satisfactorily placed, but the type species differs from *L. fraseri* in its smaller size and much shorter palpi, and in the absence of the apical tufts of short hairs on the joints of the antennae. There can be little doubt that the relationships of *L. fraseri* are with *Mimomyia* and *Ficalbia*, and from an examination of the type of *L. lateralis*, together with information kindly supplied to me by Dr. Kertész as to the relative lengths of its tibia, I am inclined to assign it to the same position.

Eretmopodites chrysogaster, Graham.

In this species the side-pieces of the hypopygium have a long thin projection on their inner dorsal side, which curves downwards and carries at its tip some very long scales which lie close together and at first sight look like a single flattened blade. These structures have been figured by Graham, but inaccurately, as he shows them attached to the base of the claspers; he also incorrectly speaks of them as the harpes.

After studying a large number of specimens of *E. chrysogaster*, I find that there are at least three distinct forms,* distinguishable mainly by the form of the scales at the tip of the above-described projection of the side-pieces. The differences, which I believe to be varietal rather than specific, are as follows:

1. *E. chrysogaster* (type form). Projections of side-pieces of hypopygium with two very long and rather narrow scales at their tips. Last two joints of male hind tarsi with a distinct paddle-like fringe of scales.

Larvae of this form have been received from Sierra Leone—Matotaka (*Dr. J. J. Simpson*) and Moyamba (*Dr. J. S. Pearson*). They have 20–40 scales (usually about

* *E. grahami*, Edw., should doubtless also be regarded as a form of *E. chrysogaster*. In its hypopygium it closely resembles, without being quite identical with, *E. chrysogaster* var. *semisimplicipes*.

30) in the comb of the eighth abdominal segment, and there are only two teeth in the pecten. Other larvae of this same form received from Uganda—Kasala (*Capt. A. D. Fraser*)—were described by the writer as having three teeth in the pecten, two short and one long. These specimens unfortunately appear to have been lost.

2. *E. chrysogaster* var. *semisimplicipes*, var. nov. Projections of side-pieces of hypopygium with four scales which are considerably broader and shorter than in the type form. Basal lobes of side-pieces carrying a transverse row of hairs as in the other two varieties, but this form is peculiar in having one of these hairs much longer than the others and dilated at its tip. Last two joints of male hind tarsi with much less distinct paddle-like fringe than in the type. This variety is represented in the British Museum collection by some specimens from Ashanti—1 ♂, Obuasi (*Dr. W. M. Graham*) and 4 ♂ 4 ♀, Akrokerri (*Dr. A. Ingram*). No larvae have been received.

3. *E. chrysogaster* var. *subsimplicipes*, var. nov. Projections of side-pieces of hypopygium with two scales which are considerably broader and shorter than in the type form. Last two joints of male hind tarsi with only a slight (though always perceptible) paddle-like fringe.

Larvae of this form have been received from Nyasaland—Mlanje (*S. A. Neave*). They have from 10–22 scales in the comb on the eighth segment, and three teeth in the pecten, nearly equal in size (one specimen has only two pecten teeth). No other differences from larvae of the type form are apparent. Adults have been received from Mlanje and also from Zanzibar (Sebeleni Swamp, *Dr. W. M. Aders*). Probably all East African specimens are referable to this variety.

Leicesteria omissa, sp. nov.

Head: scales black above, white at the sides, a narrow white rim round the eyes and a small white spot on the nape; clypeus bare. Basal and second joint of antennae with small flat white scales. Proboscis and palpi entirely black-scaled; in the female the palpi are nearly two-thirds as long as the proboscis. *Thorax* clothed with dark chocolate-brown scales above, margin narrowly white-scaled, pleurae white-scaled. Scutellum with flat blackish scales, some dull creamy ones on the middle lobe. *Abdomen* black-scaled above, first segment with a broad white patch extending evenly along the whole of each side; segments 2–7 with the usual large, oblique, subtriangular white patches, their upper edges concave. On segments 6 and 7, but not on 2–5, are small basal lateral yellow patches. The white patches do not quite reach the hind margins of the segments and are only just visible from above. *Legs* black-scaled: under sides of fore and mid femora white; hind femora whitish except near the tip and dorsally. Front tibiae markedly shorter than the middle or hind pair: first joint of the hind tarsi practically as long as the tibia. Front claws of male very unequal, the larger claw thick, with a long tooth just before the middle, the smaller one thin and untoothed; mid claws of male and fore and mid claws of female equal, each with a minute tooth; hind claws in both sexes, small, equal and simple. *Wings* with the first fork-cell with its base a little nearer the base of the wing than that of the second; lateral vein-scales linear or nearly so.

Male hypopygium: claspers much expanded apically and bearing a comb which consists of one long tooth (at the apical end) and about thirteen shorter ones; basal lobes of side-pieces with three long teeth; a patch of scales on the inner dorsal margin of each side-piece near the base.

Larva of the *Armigeres* type; elongate, whitish. Antennae short, cylindrical, the tuft represented by a single hair situated at $\frac{1}{3}$. Head tufts small; of the two median pairs one consists of two hairs, the other of three. Comb of eighth segment with about 10 scales. Siphon about as broad as long; no trace of a pecten; the small two-haired tuft situated a little beyond the middle. Anal brush well developed; gills large, slightly unequal in size.

CEYLON: 2 ♂ (including type) 2 ♀, Colombo (*Major S. P. James*); 4 ♀, Peradeniya, bred from larvae in bamboo stumps (*E. E. Green*).

L. omissa much resembles, and may be a variety of, *L. dolicocephala*, Leic., the only difference being the absence of yellow lateral spots on segments 2–5 of the abodmen. In other instances similar differences have been proved to be specific, and they are therefore accepted as such in the present case. Unfortunately the male genitalia of *L. dolicocephala* have not been described. *L. omissa* approaches the genus *Armigeres* in the greater number of teeth in the claspers.

Ochlerotatus annulifemur, sp. nov.

Head clothed with broad flat scales, which are white at the sides; black above, except for a white stripe on each side of the middle line. Proboscis rather short, scarcely as long as the antennae, clothed with dark brown scales, except for a narrow white ring in the middle. Palpi longer than the proboscis by their last joint, clothed with dark brown scales, except the last joint, which is whitish. *Thorax* clothed above with narrow curved scales, which are for the most part dark brown, but there are some yellowish brown ones on the front margin and a patch of the same colour on each side just in front of the wings. Scutellum mostly denuded, but some flat white scales are left. *Abdomen* clothed with black scales above, with white lateral patches at the base of each segment. *Legs* clothed mainly with blackish brown scales, without any lighter ones intermixed; a narrow white ring before the apex of each femur; all femora and tibiae narrowly white at the tips, and all the tarsal joints narrowly white at both ends. *Wings* clothed with brown scales, except for a few white ones near the base of the subcosta; the lateral vein-scales are fairly broad, except towards the apex of the wing. Bases of fork-cells about level.

Length about 4 mm.

INDIA: 1 ♂, Jhansi, N.W.P., Aug. 1900 (*Lt.-Col. G. M. Giles*).

The specimen was Giles' ♂ type of *Stegomyia pipersalata*, but since that name has been restricted to the female, Giles' type ♂, which belongs to quite a different species, requires re-naming. It could not possibly be confused with any other Oriental species.

Ochlerotatus jamesi, sp. nov.

Head with flat scales at the sides, two black patches alternating with two white ones; narrow yellowish scales on the occiput. Palpi and proboscis clothed with dark

brown scales. *Thorax* reddish brown, clothed dorsally with small narrow dark brown scales and some yellowish ones, the latter tending to form spots; scutellum covered with snow-white flat scales. *Abdomen* blackish above, with basal white bands on each segment; large dull white lateral spots, not visible dorsally; venter yellowish white, the apical margins of the segments dark. *Legs* with dark brown scales; undersides of femora white; all femora and tibiae with silvery-white apical spots; tarsal joints rather narrowly whitish at the base, the white rings not extending on to the apices of the joints. *Wings* with the bases of the fork-cells practically level.

Length 4–5 mm.

CEYLON: 3 ♀ (including type), Colombo (*Major S. P. James*); 1 ♀, Galle, 6. iv. 1907 (*T. Bainbrigge Fletcher*).

This species is very similar to *O. lowisi* (*Reedomyia lowisi*, Theo.) and *O. taeniatus* (*Lepidotomyia taeniata*, Leic.), from both of which it differs in the tarsal markings, the pale rings being entirely confined to the basal ends of the joints. The female from Galle was determined by Theobald as *R. lowisi*.

Ochlerotatus macfarlanei, sp. nov.

Head with a large patch of creamy narrow curved scales on the nape, round this patch is a broad border of flat black scales, and again a narrow border of yellowish narrow curved scales round the eyes; creamy flat scales at the sides; upright forked scales mainly black. Proboscis dark, the middle half with creamy scales beneath and at the sides, some whitish scales on each side at the tip. Antennae blackish, the basal joint with a few small flat yellowish scales, the second joint with some black scales. Palpi in the male reaching to the base of the labella, the last two joints with long pale hairs, bent downwards as usual, but not swollen; black, except for a few white scales about the middle of the basal joint and a patch of silvery white scales at the base of the terminal joint. Female palpi black, tipped with silvery white, hardly a quarter as long as the proboscis. *Thorax* reddish brown, with well-marked lines of golden scales, arranged as follows: a double median line extending as far back as the bare space in front of the scutellum; a line on each side of this extending the whole length of the mesonotum; and a line round the front margin, bent inwards on each side about the middle of the mesonotum and then continuing straight back to the scutellum; scutellum with narrow curved golden scales; pleurae with patches of flat white scales. *Abdomen* black above, with silvery white basal bands on each of segments 2–8, interrupted in the middle on segments 6 and 7; each of segments 2–6 has a pair of roundish creamy yellow spots in the middle, these spots are rather variable in size and in one or two specimens are wanting; there are some ill-defined patches of yellow scales at the sides of the segments. Venter clothed with yellow and black scales in varying proportions; when well exposed silvery basal lateral patches are seen on some of the segments. Ovipositor prominent, yellow, without cerci. *Legs* black; the femora pale ventrally; all the femora and the fore and mid tibiae with a longitudinal creamy yellow stripe, hind tibiae with a creamy yellow patch at the base beneath; front and middle tibiae with a white patch at the apex above; front and middle tarsi with white spots on the upper surface at the base and apex of the first and second joints and at the base of the third; hind tarsi with white rings

embracing both ends of the joints, fifth joint entirely white. Front and middle claws of male unequal, the larger with two teeth, the smaller with one; hind claws simple in both sexes. *Wings* with dark brown scales; the lateral vein-scales slightly clavate. Fork-cells with their bases practically level.

HONG KONG: 41 ♂ 82 ♀ (*Dr. H. Macfarlane*).

This is a very distinct species, though in its thoracic markings it resembles *O. pseudotaeniatus*, Giles, and *Stegomyia trilineata*, Leic. The abdominal markings are peculiar, but are paralleled by *Orthopodomyia*. To judge from the description Doleschall's *Culex aureostriatus* must resemble this species rather closely, but it has the white bands on the abdomen at the apex of the respective segments.

Culiciomyia bahri, sp. nov.

Head clothed with black upright forked scales and yellowish narrow curved scales in the middle; flat scales at the sides, which are white below and purplish black above, the white ones however extending upwards along the eye-margins towards the middle line, but they do not as in other members of the genus quite reach the middle. Basal joint of antennae blackish, without scales. Palpi and proboscis black-scaled. In the male the palpi are longer than the proboscis by a little more than the length of the last joint, the penultimate joint is only a little shorter than the terminal, and about three times as long as the labella; the projecting scales on the basal joints are much fewer, shorter and more difficult to see than in any other member of the genus. *Thorax* with the usual dull (matt) greyish-brown integument, clothed with small narrow dark brown scales, lighter on the scutellum. Pleurae pale, unscaled, without any dark markings. *Abdomen* clothed with blackish brown scales above, whitish ones below; no trace of white lateral spots at the bases of the segments, but a few paler scales at the apical corners. Male genitalia with spiny claspers and with the second plate of the harpagones long, pointed and serrate below, as in all other species of the genus. *Legs* entirely dark-scaled except for the under sides of the femora and the lateral aspect of the hind pair. *Wings* with dark brown scales; the lateral vein-scales towards the apex of the wing are linear. Fork-cells rather long, the upper one about twice as long as its stem and with its base a little nearer the base of the wing than that of the lower.

CEYLON: Badulla (*Dr. P. H. Bahr*), a series bred from larvae, 3 ♂ (including type) 4 ♀ in the British Museum, other specimens in the London School of Tropical Medicine; 1 ♀, Hakgala, and 1 ♀, Peradeniya (*E. E. Green*).

The specimens were all at first thought to be *C. fragilis*, Ludlow,* but there are abundant distinctions between the two, *C. bahri* having narrower lateral vein-scales, fewer flat white scales on the orbital margins, fewer outstanding scales and a longer penultimate joint to the male palpi, and in the genitalia more rounded side-pieces and a shorter basal projection on the harpagones. In scale characters *C. bahri* resembles *Culex* almost as much as *Culiciomyia* and might be considered as invalidating the

* *Culicomyia fragilis*, Ludlow, = *Culex fragilis*, Ludlow, = *Trichorhynchus fuscus*, Theo, = *Culiciomyia inornata*, Theo, = *C. ceylonica*, Theo. The writer's previous identification of *C. fragilis* with the African *Culiciomyia nebulosa* is incorrect.

latter genus, but as in the surface of the mesonotum and the structure of the male genitalia it is a typical *Culiciomyia* the genus is retained for the present.

Lophoceratomyia hewitti, sp. nov.

Head dark brown, clothed mainly with whitish narrow curved scales, which are densest near the eyes; flat white scales at the sides, which extend up towards the middle line, as in most other species of the genus. Male palpi not quite as long as the proboscis, the last two joints not curved upwards, about equal in length and almost devoid of hairs; no finger-like process at the base. *Antennae* of ♂: basal joint without scales, with a blunt prominence on its inner side; joints 2–7 without any specially developed scales or hairs; eighth joint with a small bunch of crumpled scales on its under or inner side; ninth segment with the usual long bent process, probably consisting of several scales adhering together; tenth and following segments normal, without any scales. *Thorax* brown above, clothed with dark brown scales and bristles, two lines of long bristles running the whole length of the mesonotum; scales on scutellum pale; pleurae yellowish. *Abdomen* clothed with dark brown scales above and dirty white ones below. *Legs* with dark brown scales, femora white-scaled beneath; claws of fore and mid legs of male unequal but apparently all simple. *Wings* with the lateral vein-scales with their apices slightly expanded; base of first fork-cell considerably nearer the base of the wing than that of the second.

SARAWAK: Matang (*J. Hewitt*), 4 ♂ (including type) 1 ♀ in British Museum; other specimens (paratypes) in Cambridge Museum.

Type presented by the Cambridge Museum.

This species resembles *L. brevipalpus*, Theo. (= *eminentia*, Leic.) in its short male palpi and in the form of the basal joint of the antennae, but differs in the absence of any tuft of scales on the sixth or seventh antennal segments. Except for the curious basal joint the antennae closely resemble those of *L. minutissima* (Theo.).*

Lophoceratomyia quadripalpis, sp. nov.

♂. *Head* clothed rather sparsely with dark narrow curved and upright forked scales; flat whitish scales at the sides, which extend up to the middle line as a very narrow border round the eyes. Palpi dark-scaled, longer than the proboscis by a little more than the length of the last joint; last two joints turned upwards, hairy; a distinct finger-like process at the base of each palp on the outer side. Proboscis dark-scaled. *Antennae* with the basal joint unscaled, normal in shape; 6th joint on its outer side with a row or tuft of about six dark brown lanceolate scales, their tips pointed, but not hair-like; seventh, eighth and ninth segments with the usual tufts of black crumpled scales, those on the ninth segment much the longest; tenth segment with about five lanceolate, sharp-pointed, light brown scales on its under side (very

**Lophoceratomyia miuntissima* (Theo.) = *Culiciomyia minutissima*, Theo. = *C. nigerrima*, Theo. = *Melanoconion juxtapallidiceps*, Theo. I have recently had an opportunity of examining a good series of both sexes of this species collected by Major S. P. James in Ceylon. A male had also been included accidentally by Theobald in his series of *L. uniformis*. The type male of *L. uniformis* has a mammillate basal antennal joint and belongs in fact to the same species as *L. bicornuta*, Theo., and *L. mammillifer*, Leic.; over both these last names *L. uniformis* takes precedence.

difficult to see); eleventh segment with one or two of the verticillate hairs on the under side thicker than the others; remaining segments normal. *Thorax* reddish brown, clothed with dark brown scales, scutellum lighter. *Abdomen* entirely clothed with dark brown scales above, lighter below. *Legs* with dark brown scales, femora whitish beneath; claws of front legs unequal, both toothed; on middle legs unequal, the larger one simple, the smaller toothed. *Wings* with the lateral vein-scales slightly clavate; first fork-cell with its base slightly nearer the base of the wing than that of the second.

SARAWAK (*J. Hewitt*), 3 ♂ (including type) in the British Museum; other male specimens (paratypes) in the Cambridge museum.

Type presented by the Cambridge Museum.

This species rather closely approaches several others. From *L. fraudatrix*, Theo., it differs in the much smaller tuft of scales on the sixth antennal segment; from *L. rubithoracis*, Leic., in having these same scales much less pointed; and from *L. taeniata*, Leic., in the unbanded abdomen and the larger projection at the base of the palpi. The scales, etc., on the antennae are exactly the same as in *L. taeniata*, and *L. quadripalpis* may therefore be only a variety of that species.

Uranotaenia metatarsata, sp. nov.

Head clothed entirely with flat black scales; proboscis black-scaled; antennal plumes black. *Thorax* with the dorsum brown, rather thinly clothed with dark brown scales; pleurae yellowish, unscaled; no line of flat scales in front of the base of the wings. *Abdomen* with blackish brown scales, and with small lateral apical pale spots on each segment. *Legs* entirely clothed with dark brown scales; claws normal. On the front legs the first joint of the tarsus is shorter than the second, curved, with a small tuft of scales on the under side just beyond the middle. Middle and hind legs normal. *Wings* with brown scales, those on the apical portion of the wing lanceolate.

Length about 2 mm.

MALAY STATES: 2 ♂, marshy ground on Circular Road, Kuala Lumpur, 28. viii. 1903 and 9. x. 1903 (*Dr. G. F. Leicester*).

This is the third species to be described in this genus with modified front tarsi in the male. The other two (*U. cancer*, Leic., and *U. abnormalis*, Theo.) have the first joint of the front tarsi of quite different form, and both belong to the other group of *Uranotaenia* in which there is a line of flat scales in front of the wing-base.

ON THREE SPECIES OF XENOPSYLLA OCCURRING ON RATS IN INDIA.

By the Hon. N. Charles Rothschild, M.A., F.L.S.

As it is now generally admitted that one or more of the species of fleas occurring on the common rats, *Mus rattus* and *Mus norvegicus*, are concerned in the transmission of plague, the study of these fleas has become a matter of the highest importance in connexion with the prevention of the disease. The first point that demands elucidation at the hands of medical entomologists is the identity of the species that is or are responsible. When this point has been satisfactorily determined, attention can be directed to the detailed study of the bionomics of the obnoxious species, as a preliminary to the adoption of appropriate remedial measures. It will be obvious that a *sine qua non* to a successful attack on the problem is the ability of the investigator to discriminate the various species that he is likely to meet in his researches, and it is the object of the author of these notes to supply a key to the identification of the species of *Xenopsylla* that occur on rats in India.

So far as is known, three species of the genus just named are to be found on Indian rats. These species occur in widely varying proportions, according to the part of the country in which the hosts are taken. Not infrequently two—and at times all the three—species are to be found on a single rat. As it happens, the three species are very much alike and can only be distinguished with certainty under a good microscope; a hand-lens is absolutely useless for the purpose. Apart from this, the accurate diagnosis of these species requires practice, and it is within the knowledge of the author that some medical officers find no little difficulty in connexion with this matter. Just as an inflammation of the epidermis does not necessarily denote a case of scarlet fever, so the absence of a comb on a rat flea does not prove the species to be *Xenopsylla cheopis*.

Before proceeding to a description of the chief distinguishing characters of the species under consideration a few remarks as to the technique of the necessary examination may not be amiss. Fleas that have been freshly caught or have been preserved in alcohol are sometimes too opaque when examined with a microscope by transmitted light. Such specimens must therefore first be cleared. This is best effected by boiling them for an hour or more in oil of cloves, after which they should be allowed to remain in the oil for a whole day. This procedure however is usually unnecessary, as a sufficiently clear view can generally be obtained if a moderate pressure is applied to the cover-slip under which the specimen is being examined. If the specimen be a female and there be a difficulty in observing the receptaculum seminis, it is usually possible to carry out the necessary observations by turning the insect over and examining it again. It may be added that, although as a general rule most fleas are more readily determined from the male sex, in the case of these Xenopsyllas the shape of the receptaculum seminis is so distinctive a character that the females are probably the easier of the two to identify.

I. MALES.

1. **Xenopsylla brasiliensis,** Baker. The long dorsal bristle situated on the seventh abdominal segment in front of the pygidium (the *antepygidial bristle*) is placed on a long *pedestal*, which projects beyond the apex of the seventh segment. This is not the case in the female of *brasiliensis*, nor is it so in either sex of *X. cheopis* and

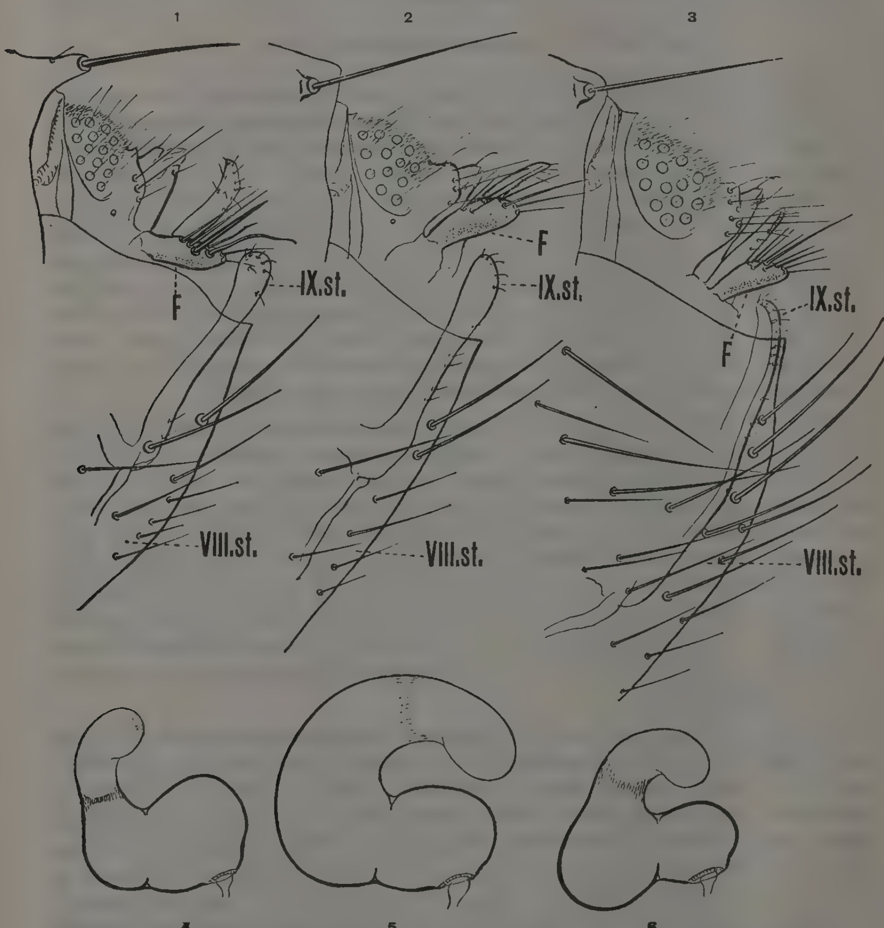


Fig. 1.—Modified abdominal segments of the male of *Xenopsylla brasiliensis*.—— F, outer flap of clasper ; viii st. and ix st. eighth and ninth sternites.

2.—The same of *Xenopsylla cheopis.*

3.—The same of *Xenopsylla astia.*

4.—Receptaculum seminis of *X. brasiliensis.*

5.—The same of *X. cheopis.*

6.—The same of *X. astia.*

astia. The outer flap of the organs of copulation is studded with very stout bristles, the longest of which is curved like a boomerang.

2. **Xenopsylla cheopis,** Roths. The antepygidial bristle is situated on a short *pedestal,* which is placed at some distance from the apical edge of the seventh segment. The outer flap of the copulatory organs is sole-shaped, its upper edge being more curved than the lower edge. This flap bears nine or ten bristles on the outer surface, these bristles being very much thinner than in *brasiliensis* and drawn out into a long thin point. The ninth sternite, which usually projects but slightly from the interior of the eighth segment, is widened towards the apex, having more or less the shape of a club of which the upper side is somewhat flattened. The upper margin of this club is as distinct as the ventral margin when viewed by transmitted light under the microscope.

3. **Xenopsylla astia,** Roths. The antepygidial bristle is similar to that of *X. cheopis.* This species, however, in the male, is easily differentiated from the other two species by the shape of the ninth sternite. This sternite, instead of being club-shaped, has the appearance of a ribbon viewed from a point on its edge, which is due to the ventral margin being strongly chitinised, whereas the sides and upper margin are very thin and transparent. The outer flap of the organs of copulation is narrower than in *X. cheopis* and bears fewer bristles. The species is replaced in Africa by *X. nubicus,* which differs in minor details only.

II. Females.

The three species are distinguished at a glance by the shape of the receptaculum seminis. This organ is divided by a deep constriction into a short rounded portion, the "head," and a more or less sausage-shaped portion, the "tail."

1. **Xenopsylla brasiliensis.** The "head" of the receptaculum seminis is very much wider than the "tail." The abdominal segments III to VI bear ventrally on each side a row of 4 bristles, and the eighth segment has on the outer surface less than 20 bristles.

2. **Xenopsylla cheopis.** The "tail" of the receptaculum is much longer than in *X. brasiliensis* and, near the constriction, distinctly wider than the "head." The abdominal segments III–VI bear ventrally on each side a row of three or four, rarely five, bristles, and the eighth segment has less than 30 bristles, usually 20 to 25.

3. **Xenopsylla astia.** The "tail" of the receptaculum is so strongly widened near the constriction that it is here very much wider than the "head"; the "tail," moreover, is shorter than in *X. cheopis.* The abdominal segments III–VI bear ventrally a row of seven or eight bristles on each side, and segment VIII has more than 30 bristles on the outer surface.

SUGGESTIONS FOR THE LIMITATION AND DESTRUCTION OF GLOSSINA MORSITANS.

By J. O. Shircore, M.B., M.R.C.P.(Edin.)

Medical Officer, East Africa Protectorate.

(Sketch-Map.)

"Primary Fly Centres": Their Influence on the Distribution of G. morsitans.

Several months' constant travelling in the "proclaimed area" has led the writer to conclude that it contains at least four "primary centres" which harbour tsetse-flies, situated as shown on the map as follows:

No. 1, opposite Rifu, near Patsanjoka Marsh;
No. 2, W. & S.W. of Kuti Marsh;
No. 3, at Nyansato near the Chitawa Marsh; and
No. 4, along and on each side of the Lingadsi River, between Long. 38° 8′ and 34° 13′ E.

The main reasons why these are defined as "primary centres" are: (1) Fly are found here abundantly throughout the year. (2) They are present in these situations when there are none or extremely few elsewhere, when the whole country is bare of grass, the trees without foliage, and the ground baked hard. (3) These are the only areas where in the dry season water is actually above the earth's surface or at no great depth below. For example, at the Lingadsi River the centre is almost definitely limited in length by the water and moisture in the river-bed. At Patsanjoka the water is present throughout the dry season. At Kuti and Chitawa it dries late, but here it is seen that although the marshes are superficially dry, yet during late October and early November, before any rain, fresh grass already springs up and trees begin to put on green foliage in the low-lying country near the marshes; this is in marked contrast to other parts of the district, *e.g.*, the portions between Nsadzu, Waya and Matumba to Mtalamanja, that being somewhat raised undulating broken country with a fairly rocky surface. (4) It is in these situations that the fly can best feed during the long season of drought; there are herds of eland and buffalo at the Lingadsi; waterbuck, hartebeest and eland at Nyansato; and various species of large and small game at Patsanjoka and Kuti dambos, and numbers of these can be seen at various times resting in the shade during the heat of the day. (5) In these places there is light forest with fairly short grass, here and there open glades, and water at no great distance, a combination which is ideal for both game and fly. The latter feed as the game come to and from water, and the light forest enables them to see and follow the game without difficulty. Heavy forest, and thick high grass impede the flight of tsetses, and moreover they are unable to see any distance. They are sometimes found in such situations, but not in any numbers.

The fact that the fly are found at the above-mentioned centres all the year round and that they still exist there at the height of the dry season, when there are few or none elsewhere, makes it quite reasonable to suppose that they breed at these places, and that it is from these centres that they extend into the surrounding country along

connecting forest as soon as the conditions become suitable. This is actually observed to take place. During May, June, and early July, tsetses are to be found constantly, though in small numbers, along routes where during August and September they absolutely disappear, or are present in almost negligible numbers, or only at odd times. This applies to almost all the main routes, except just at and opposite the four centres indicated. During late September, October and November a distinct but gradual increase becomes evident, and during November, before the rains, flies re-appear in situations in which they were to be found early in May. Radiations from the primary centres begin about this period, so far as the physical character of the country, the large garden clearings and the seasonal conditions allow. With the onset of the rains the spread increases, as more suitable situations are created; the rough stony country becomes a habitat and other breeding centres—" secondary centres "—are established. The fly thus continues to increase until the rains are over, the streams dry, and the grass withered, and then the hot season with its bush-fires once more performs a natural prophylactic measure.

On regarding the subject from this aspect, the measure which I advocate is that the forest connections along which radiations take place should be cut off, or otherwise dealt with, early in the year, about May, so that the actual " primary centres," which should have been *delimited at the height of the previous dry season*, are isolated. After this has been performed, all the trees in these centres should be cut down and left to dry, and by the end of July or August, when the whole country is parched (grass-fires having been strictly prohibited during this period), wholesale and extensive burning should be carried out over these areas, commencing from the side of the " extensions " and progressing towards the main and isolated bodies of fly. At Kuti, Nyansato and Patsanjoka (Rifu) this could be done, and with especial ease at the last situation. At Lingadsi it would be difficult, but sufficient could be done here to prevent a southern extension which links up with the north arm of the Nyansato area during the rains.

If " extensions " depend on primary sources, as they undoubtedly do, then it must needs follow that their limitation or the lessening of their numbers must lessen the formation of " secondary centres " and their " extensions " and will therefore curtail the distribution and numbers of the fly.

Game plays a minor part in the actual habitat of *G. morsitans*. It is true that in the above-mentioned areas game is plentiful and that blood is necessary to the life of the fly, but there are numerous situations where game is present in this same prohibited area, yet fly are not found, and where fly though present during the wet-sesaon are absent during the dry.

The effect of prophylactic forest cleaning on G. morsitans.

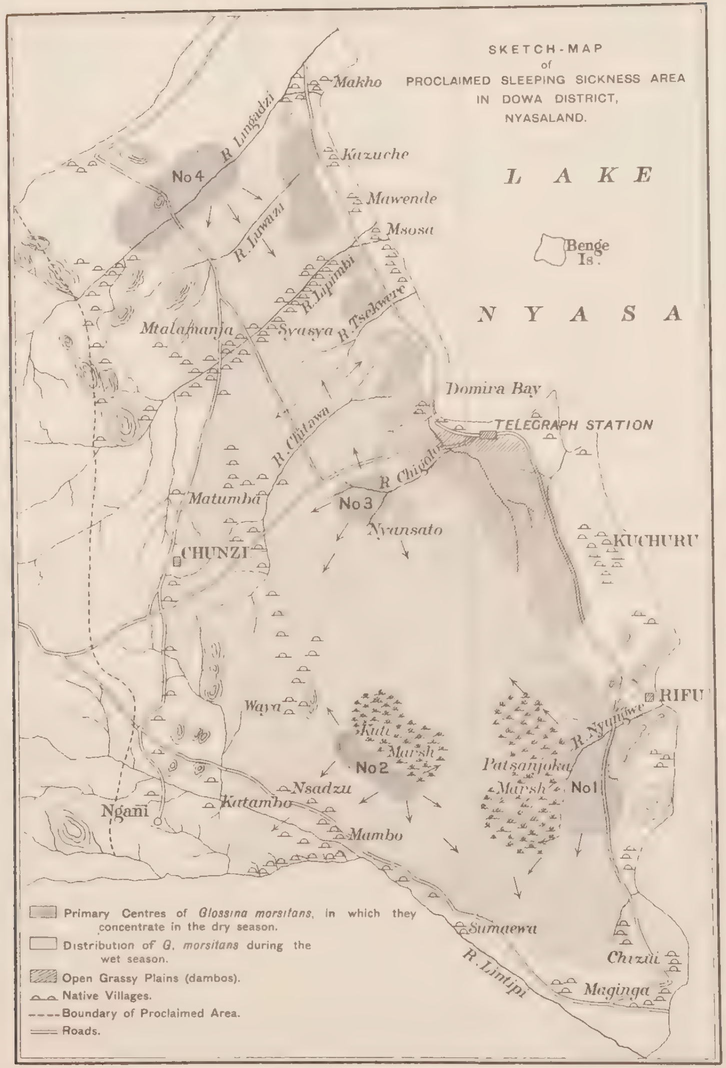
With a view to indicate the results of even moderate clearings of some 150 yards around villages in the " proclaimed area," a few observations may well be recorded. Before such measures were adopted it was noticed that clearings made for agricultural purposes by the inhabitants of a certain chain of villages lying east of Mtalamanja, and north and south of the River Lipimbi along its course to Lake Nyasa, shewed a decided effect, as compared with other parts of the district, on the distribution of *G. morsitans*, which was further emphasised by the clearing of areas in the vicinity of

these villages. African villages as a rule have more or less definite patches of forest, light or otherwise, surrounding them, for various reasons. The paths from such villages leading to main roads, gardens, water supplies and neighbouring villages traverse these patches and it is in such positions that tsetses are found. Where there are groups of villages arranged somewhat in continuity, one does not find much game immediately near or between such habitations, at any rate not during the day, yet in fly districts tsetses are invariably present in such situations, if the conditions are not unsuitable, such as " dambo " areas or sandy soil near the lake, and rough rocky elevated country with little vegetation inland. Such places are unsuitable for much vegetable growth, superficial moisture is absent and subsoil water is probably at a great depth; forest cannot support itself and without some continuity of trees, however irregular, fly cannot exist in any numbers. Travelling through such areas fly are not seen, nor are they found feeding on game shot in " dambos," except when near the fringe of forest harbouring the fly. It is observed that in favourable places some distance from dense fly " centres," one finds small belts or rings of fly congregated round villages and in forest patches on one or other or both sides of the roads between villages, the numbers fluctuating according to the season. So that the villagers are constantly fed on, for the greater part of the year, by these flies every time they leave or return to their villages. It is obvious that inland villages must generally be situated, in such positions; forest is to the native not only an indication of arable land, but is also a protection from heat and weather conditions; the timber and grass is utilised for building purposes and fuel. Water supplies must also be near at hand, and as these conditions—*i.e.* forest and relative humidity, together with the natives, their sheep, goats and dogs—supply all the wants of the fly, they therefore are likely to persist in frequenting these haunts. It is seen that along the River Lipimbi the rough continuity of villages, *i.e.* 19 over a distance of some 8½ miles, their garden-clearings, etc., has performed a natural division of the fly-belt at the junction between its southern extension from the Lingadzi area (No. 4) and the northern extension from the Nyansato area (No. 3).

The prophylactic clearings which were adopted made a still further and decided impression, so much so that after the summer grass fires had swept the country scarcely a single fly was noticeable along the road between Mtalamanja's village and Msosa's, the latter being situated at the Lake. Again it was noticed that before village clearing was performed, fly which followed one during journeys from Domira Bay—they being first met shortly after crossing the " dambo " opposite area No. 3—kept one company till Matumba's village, and through Matumba's group of villages well along the Chunzi Road; in fact, some invariably came into the Medical Officer's house at Chunzi with the " safari." When subsequently clearing was performed at Matumba's, it was found that this area acted as a check to the progress of the fly; they dispersed shortly after passing the edge of the clearings, and the few that followed would be lost while going through the villages. Other instances could be quoted shewing these effects in varying degree, according to the nearness of villages to the main " fly centres " and the physical character of the country. For example, some villages are protected from fly by their slightly elevated rocky sites; others by being situated near stream-beds which are dry during the summer and in which the subsoil water is at a depth of 8 to 12ft.; and others by small abruptly rising hills which

prevent an extension of the fly-belts. When these facts are considered, the formulating of systematic prophylactic measures becomes a matter of comparative ease; but a thorough knowledge of the country is essential. What is suitable in one place may not be so in another, and each area must be dealt with according to its particular requirements.

The clearing of villages, the increase of agriculture, the splitting up of fly-belts near villages and along main routes by forest destruction and burning, the attacking of "fly centres," as indicated above, cannot otherwise than profoundly modify the entire distribution of *G. morsitans* in inhabited areas. These practical methods would ultimately limit fly to areas which need not be entered by natives while carrying on their ordinary means of livelihood, and further those who contracted trypanosomiasis, after entering these "segregated fly areas," would be harmless as regards the spread of the disease.



SKETCH-MAP
of
PROCLAIMED SLEEPING SICKNESS AREA
IN DOWA DISTRICT,
NYASALAND.
LAKE
NYASA
Benge Is.
Makho
Kazuche
Mawende
Msosa
R. Lingadzi
R. Luwazi
R. Lapimbi
R. Tsekwere
No 4
Mtalamanja
Syasya
Domira Bay
TELEGRAPH STATION
R. Chitawa
R. Chigolo
Matumba
No 3
Nyansato
CHUNZI
KUCHURU
RIFU
R. Nyamwe
Waya
Kuti
Marsh
No 2
Patsanjoka
Marsh
No 1
Nsadzu
Katambo
Ngani
Mambo
Sumaewa
R. Lintipi
Chizili
Maginga
Primary Centres of Glossina morsitans, in which they concentrate in the dry season.
Distribution of G. morsitans during the wet season.
Open Grassy Plains (dambos).
Native Villages.
Boundary of Proclaimed Area.
Roads.

A DIPTEROUS PARASITE OF GLOSSINA MORSITANS.

By Ernest E. Austen.

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The Imperial Bureau of Entomology has recently received from Mr. Ll. Lloyd, Entomologist to the British South Africa Company in Northern Rhodesia, a small Bombyliid fly accompanied by the following letter, dated "Mwengwa, Mumbwa, *viâ* Broken Hill, N. Rhodesia, November 1, 1913.—I am sending you herewith a specimen of a Dipteron, which I believe to be a parasite of *G. morsitans*. During July and August of this year I collected about 700 pupae of this Tsetse in nature at Ngoa, in the Mpika Division of Northern Rhodesia. These were kept under observation until September 15th, when I was compelled to travel through fly-free country for a month; they were accordingly closed up in a fly-proof case to avoid escape (in case of possible fracture of one or more of the bottles containing the pupae), and were not examined again until October 18th. On this date one of the bottles, which had contained five Tsetse pupae collected on July 21st, was found to contain :—

"(1) Two pupae from which the flies had not emerged.

"(2) Two empty puparia, with the old Tsetse pupal skin showing inside in the normal manner, and with the head cap normally split.

"(3) Two dead Tsetse.

"(4) Another Dipteron, very dry and broken.

"(5) The pupal case from which this fly had undoubtedly emerged.*

"(6) The fifth Tsetse puparium, the head cap of which had been roughly split; this puparium contained no trace of the old pupal skin.

"The pupae had been carried in a strong beaker, the mouth of which was closed with three layers of mosquito muslin, so that it would have been almost impossible for the larva of the insect to find its way into the tube. The pupa also seems to be adapted to breaking through hard cases by means of the short spines on the head. There appears therefore to be no doubt that the pupa of the Tsetse was parasitised at the time of collection, and that the parasitic pupa emerged from it between September 15th and October 18th."

Although, as indicated by Mr. Lloyd in his letter, the parasite thus unexpectedly obtained is somewhat damaged, it is fortunately not so much injured as to prevent

*This is of the normal Exoprosopine type, having on the antero-inferior part of the head-capsule a group of four tubercles, or teeth, of chitin, with black, strongly chitinised cutting-edges, and a little further back a pair of similar but smaller teeth on the proboscis-sheath. The dimensions of the pupa case are: length 6 mm., greatest breadth 2·6 mm.—E.E.A.

its being described and figured. The insect proves to belong to a new species, which may be characterised as follows :—

Family BOMBYLIIDAE.

Subfamily EXOPROSOPINAE.

Genus Villa, Lioy.

Villa lloydi sp. nov. (fig. 1.).

♂.—Length (one specimen) 5·75 mm. ; width of head 2·2 mm. ; width of front at vertex 0·25 mm. ; length of wing 5·25 mm.

Black ; dorsum of abdomen marked, as shown in fig. 1, *with alternating transverse bands of pale (buff-coloured) and dark (black), narrow, elongate scales, third segment also with a narrow band of white scales, tapering towards middle line where it appears to be more or less widely interrupted ; wings entirely hyaline, discal and third posterior cells shaped as shown in* fig. 1 ; *legs black.*

Fig. 1—*Villa lloydi*, Austen, ♂, × 9.

Head black ; front clothed with buff-coloured scales, mixed on lower two-thirds with fine, erect, blackish hair ; face convex and somewhat prominent, but not conical, clothed with buff-coloured scales and short black hair : occiput clothed above and on upper portion of sides with yellowish white or whitish scales, clothed below with blackish hair ; *antennae* black, first and second joints clothed with stiff black hair, longer on first than on second joint, third joint bulb-shaped, tapering quickly just beyond middle. *Thorax* : dorsum, except front margin and lateral borders, clothed with appressed hairs and narrow scales, which are raw-sienna-coloured in front and become pale (cream-buff) on hinder part of main portion and on scutellum ; fringe of erect hair on front margin of dorsum yellowish, lateral borders of dorsum, from humeral to postalar calli, clothed with appressed bright yellowish-white hair ; postalar calli each with a row of (apparently about four) long, cream-buff bristles ; hind margin of scutellum bearing a series of black bristles, set at wide intervals ; pectus and pleurae clothed with black or blackish hair, mesopleurae with a tuft of yellowish hair on upper border. *Abdomen* : lateral extremities of tergites of first and second segments thickly clothed with erect whitish hair ;

tergites of fourth, fifth, and sixth segments, or at least of fourth and sixth, with a more or less distinct patch of white scales at each lateral extremity, tergite of seventh segment with a band (less deep on each side than in middle) of glistening whitish scales at base; tergites of third to sixth segments inclusive with some fine black hairs at each lateral extremity; clothing of venter, with exception of last segment and of some yellowish hairs near base, uniformly black. *Halteres* buff-coloured (knobs cream-buff at tips). *Legs*: front tibiae smooth (middle legs wanting in case of type), bristles on posterior femora and tibiae black.

NORTHERN RHODESIA: type from Ngoa, Mpika Division, between Sept. 15th and Oct. 18th, 1913, bred from puparium of *Glossina morsitans*, Westw. (*Ll. Lloyd*: presented to the British Museum by the Imperial Bureau of Entomology).

So far as the author is aware, *Villa lloydi* is the first Dipteron to be recorded as parasitic on any tsetse-fly, and Mr. Lloyd, in whose honour the new species is named, is heartily to be congratulated on a most interesting discovery.

In conclusion, it is perhaps advisable to add a few words as to the systematic position of the species described above. Owing to the shape of the discal and third posterior cells in the wing (*see* fig. 1), the venation in this species is not that of a typical member of the genus *Villa*, Lioy. As regards the details mentioned, *V. lloydi* resembles certain Ethiopian species assigned by Bezzi to the subgenus *Thyridanthrax*, O. Sack., though the species referred to are themselves aberrant in these respects, as also in their wings being entirely or almost entirely hyaline. *Villa lloydi*, however, cannot be included in *Thyridanthrax*, since the face instead of being conical is merely bluntly convex. Although it may ultimately prove necessary to institute a new subgenus for the reception of this species, such a step must in any case be postponed until further material is received.

COLLECTIONS RECEIVED.

The thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly presented collections of insects (received between 1st October and 31st December, 1913) :—

Dr. W. M. Aders :—5 Culicidae, 67 *Chrysops*, 14 *Haematopota*, 53 *Tabanus*, 16 Nycteribiidae, 82 other Diptera, 1 slide containing 6 Chalcididae, 7 other Hymenoptera, 7 Coleoptera, 6 Lepidoptera, and 13 spp. of Coccidae; from Zanzibar.

Agricultural Department of the Gold Coast :—132 Hymenoptera and 3 pupa cases, 147 Lepidoptera and 2 pupa cases, 4 Odonata, 6 Planipennia, 46 Rhynchota, and 42 Orthoptera ; from the Gold Coast.

Dr. W. M. Allen, M.O. :—50 Culicidae ; from Freetown, Sierra Leone.

Mr. T. J. Anderson, Chief of Entomological Division :—88 Culicidae, 2 *Pangonia*, 3 *Glossina*, 7 other Diptera, 355 Coleoptera ; from British East Africa.

Mr. E. Ballard, Government Entomologist :—12 Braconidae, 2 Ichneumonidae, 1 Chalcid, 5 Cassididae, and 8 Lepidoptera ; from Zomba, Nyasaland.

Mr. G. E. Bodkin, Government Biologist :—4 *Tabanus*, 11 other Diptera, 48 Hymenoptera, 21 Coleoptera, 11 Lepidoptera, 1 sp. of Coccid, 28 other Rhynchota, 2 Orthoptera and 19 Ticks ; from British Guiana.

Mr. J. R. Bovell, Superintendent of Agriculture :—2 *Stomoxys*, 6 other Diptera, 23 Hymenoptera, 22 Coleoptera, 4 Rhynchota, 2 Orthoptera ; from Barbados.

Dr. G. R. H. Chell, M.O. :—66 Culicidae, 5 *Pangonia*, 2 *Diatomineura*, 3 *Haematopota*, 17 *Tabanus*, 27 *Glossina*, 1 Hippoboscid ; from Moyale, British East Africa.

Mr. E. Dayrell, Dist. Commissioner :—23 *Chrysops*, 12 *Tabanus*, 19 *Glossina*, 2 other Diptera ; from Ahoada, S. Nigeria.

Mr. C. M. Dobbs, District Commissioner :—14 *Haematopota*, 50 other Diptera, 30 Hymenoptera, 21 Coleoptera, 1 Lepidopteron, 1 dragon fly, 5 Rhynchota ; from Lumbwa District, British East Africa.

Mr. R. A. F. Eminson :—4 *Tabanus* ; from Mwengwa, N.W. Rhodesia.

Mr. A. E. Evans, Agricultural Instructor :—3 *Rhinomyza*, 2 *Hippocentrum*, 1 *Chrysops*, 8 *Tabanus*, 46 *Glossina*, 1 *Hippobosca*, 136 other Diptera, 17 Hymenoptera, 1,378 Coleoptera and 1 pupa, 28 Lepidoptera and 9 pupae, 4 Odonata, 10 Planipennia, 606 Rhynchota and 8 pupae, 9 Orthoptera, 22 Ticks and 3 Spiders ; from the Gold Coast.

Dr. H. R. M. Ferguson, M.O. :—4 *Glossina*, 1 Asilid, 11 Ticks ; from Okigwe, S. Nigeria.

Mr. C. Fuller, Assistant Chief of Division of Entomology :—Nematodes attacking lawn grass ; from Pretoria, South Africa.

Dr. Mercier Gamble :—2 *Glossina* in spirit, 2 tubes of Fleas, and 772 Ticks ; from Portuguese Congo.

Dr. Lewis Gough, Government Entomologist :—10 Hymenoptera and 3 Moths ; from Cairo.

Mr. C. C. Gowdey, Government Entomologist :—10 Diptera, 9 Oestrid larvae, 735 Hymenoptera, 601 Coleoptera, 5 Lepidoptera, 13 Cimicidae, 5 spp. of Coccidae, 431 other Rhynchota, 649 Orthoptera, 8 Mallophaga, 62 Ticks, 1 Spider and a tube containing Mites ; from Entebbe, Uganda.

Dr. H. F. Hamilton, M.O. :—72 Culicidae, 20 *Glossina*, 1 other Dipteron, 3 Hymenoptera, 3 Coleoptera and 1 larva, 1 Lepidopteron, 1 Myrmeleonid, 1 Orthopteron, 3 Spiders and 2 Scorpions ; from Central Province, Gold Coast.

Dr. E. Hopkinson, D.S.O. :—12 Culicidae, 9 *Chrysops*, 138 *Tabanus*, 41 *Glossina* ; from Gambia.

Mr. E. Hutchins, Chief Veterinary Officer :—21 *Glossina*, 5 Anoplura, and 43 Ticks ; from Uganda.

Imperial Department of Agriculture for the West Indies :—5 *Stomoxys*, 140 other Diptera, 6 Coleoptera, 5 Lepidoptera, 1 larva and 4 pupae, 129 Fleas, 318 Ticks, and 25 tubes containing intestinal worms ; from West Indies.

Dr. A. F. Kennedy, M.O. :—1 Culicid, 3 *Tabanus*, 6 *Glossina* and 1 *Lynchia* ; from Gambia.

Mr. H. H. King, Government Entomologist :—119 Diptera, 1 larva and 9 Coleoptera ; from Anglo-Egyptian Sudan.

Dr. W. A. Lamborn, Government Entomologist :—6 *Hippocentrum*, 1 *Haematopota*, 4 *Glossina*, 334 other Diptera, and 3 pupa cases, a large number of Parasitic Hymenoptera and cocoons, 92 other Hymenoptera, 77 Coleoptera and 1 pupa, 91 Lepidoptera and 10 early stages, 1 Planipennia, 9 spp. of Coccidae, 17 other Rhynchota, 13 Orthoptera, and 1 Centipede ; from S. Nigeria.

Mr. Ll. Lloyd :—2 *Glossina morsitans* and 4 puparia and 1 Bombyliid-fly bred from pupa of *G. morsitans* ; ~~from Lagos, S. Nigeria~~. N. Rhodesia

Mr. C. P. Lounsbury, Chief of Division of Entomology :—56 Coleoptera ; from Pretoria, South Africa.

Dr. Harold Macfarlane, Government Bacteriologist :—3,182 *Stegomyia* mosquitoes ; from Hong Kong.

Mr. S. A. Neave : 1 Culicid, 8 *Chrysops*, 23 *Pangonia*, 3 *Haematopota*, 43 *Tabanus*, 3 *Glossina*, 60 *Stomoxys*, 21 Hippoboscidae, 5 cases of Asilids and prey, 28 Dipterous parasites on Lepidopterous pupae, 349 other Diptera, a number of Hymenopterous parasites on Lepidopterous larvae and pupae, 833 other Hymenoptera, 793 Coleoptera, 31 bred Lepidoptera and early stages 1,015 Moths, 19 Isoptera, 279 Rhynchota, 29 Orthoptera, 23 Siphonaptera, 2 Anoplura, 354 Ticks, 2 Chelifers, and 57 Mites ; from Nyasaland.

Dr. J. E. S. Old, M.O. :—72 Culicidae, 7 *Tabanus*, 99 other Diptera, 7 Dipterous larvae, 111 Hymenoptera, 193 Coleoptera, 6 larvae, a number of Lepidopterous larvae, 2 pupae, 1 Cocoon, 1 Termite, 483 Rhynchota, 27 Orthoptera, 118 Ticks, a large number of mites, a tube containing intestinal worms, 1 Spider, 6 Centipedes, 2 Milipedes, 1 Scorpion, 2 Snakes, and 1 Frog ; from Port Herald, Nyasaland.

Mons. T. Paczoski :—49 *Hyponomeuta malinellus* ; from Cherson, Russia.

Dr. J. Pollard, M.O. :—13 Culicidae, 1 Cimicid ; from Yola, N. Nigeria.

Hon. N. C. Rothschild :—3 *Dermacentor circumguttatus* and 2 *Amblyomma petersi* ; from Uganda.

Mr. A. Rutherford, Government Entomologist :—1 *Haematopota*, 1 *Tabanus*, 14 other Diptera, 20 slides of Chalcididae, 8 other Hymenoptera, 4 tubes containing a large number of beetles and 32 other Coleoptera, 8 Lepidoptera, 1 slide of Psocidae, 8 slides of Thrips and 4 Rhynchota ; from Peradenyia, Ceylon.

Mr. W. H. Patterson, Government Entomologist :—70 Culicidae, 24 *Hippocentrum*, 5 *Haematopota*, 1 *Tabanus*, 33 *Glossina*, 22 nests of Hymenoptera, 2 *Hippobosca*, 1,007 other Diptera, 1,088 Hymenoptera, 12 pupa cases of Parasitic Hymenoptera, 1,570 Coleoptera, 968 Lepidoptera, 1 Dragonfly, 4 Ephemeridae, 32 Planipennia, 3 spp. of Coccidae, 824 other Rhynchota, 80 Orthoptera, 6 Cocoons and 2 Spiders ; from Aburi, Gold Coast.

Capt. W. S. Patton, I.M.S. :—42 *Chrysops*, 101 *Tabanus*, 52 *Philaematomyia* ; from Guindy, Madras.

Dr. M. Saunders, M.O. :—5 *Dorcalaemus*, 4 *Haematopota*, 116 *Tabanus*, 4 *Stomoxys*, 2 other Diptera ; from Chiromo, Nyasaland.

Dr. E. S. Sieger, M.O. :—2 *Tabanus*, 6 *Haemaphysalis* ; from Oweri, S. Nigeria.

Dr. A. T. Stanton :—49 Culicidae, 3 Chironomidae, 5 *Haematopota*, 20 *Tabanus*, 4 *Stomoxys*, 11 other Diptera, and 1 Fulgorid ; from Kuala Lumpur.

Mr. Thos. Thornton :—1 *Haematopota*, 1 Tachinid, 1 Braconid, 12 Chalcididae, 4 Coccinellidae, 3 Moths, 1 Cicada ; from Aguji, Ilorin, N. Nigeria.

Mr. F. W. Urich :—1 *Dermatobia hominis*, 2 Limacodid Moths and 1 larva ; from Trinidad.

Mr. Vargas Vergora, Director of Agriculture :—5 *Tomaspis* sp. n ; from Bogota, Colombia.

Dr. A. H. Wilson, M.O. :—74 Culicidae, 17 *Chrysops*, 18 *Tabanus*, 17 *Glossina*, 1 *Stomoxys* ; from Degema, S. Nigeria.

Dr. J. Y. Wood, M.O. :—239 Culicidae, 155 larvae, and 90 pupae, 1 *Rhinomyza*, 1 *Chrysops*, 20 *Hippocentrum*, 129 *Haematopota*, 13 *Tabanus*, 275 *Glossina*, 2 other Diptera ; from Sierra Leone.

Mr. R. C. Wood :—2 *Chrysops*, 1 *Haematopota*, 27 *Tabanus*, 1 *Simulium*, 27 other Diptera, 4 Odonata with parasites ; from N. Rhodesia.

Mr. R. C. Wroughton :—236 Diptera ; from Natal, S. Africa.

Yellow Fever (West Africa) Commission :—9 *Stegomyia fasciata* and 5 *Culiciomyia nebulosa* ; from Lagos, S. Nigeria.

TSETSE FLY AND BIG GAME IN SOUTHERN RHODESIA.

By Rupert W. Jack, F.E.S.,

Government Entomologist, Southern Rhodesia.

(Maps I and II).

In Southern Rhodesia conditions are better than in most other parts of Africa for gathering information concerning the distribution of tsetse in the past, and perhaps even in the present. This is due to a combination of two factors, namely, that only one species of tsetse, *Glossina morsitans*, is found within our borders, and that the territory, in comparison with the Central African States, contains and has contained a relatively large European population. The first factor eliminates the possibility of confusion of species in connexion with the evidence forthcoming, at least in the case of those able to distinguish tsetse from other species of blood-sucking flies, whilst the second provides a more reliable source of information than the native.

In the course of the past five years, native commissioners, officers of the police, and other residents especially familiar with certain districts of the territory, have been laid under contribution for information concerning the former limits of the fly-infested areas, and in this way many valuable facts have come to light. These combined with what we have learned from the early hunters and explorers, and the knowledge gained of the present limits of the fly, obtained from all available sources and from personal observation, form a history, incomplete indeed, but still of some interest, which may be of value as a contribution to the sum of knowledge concerning this insect.

The most important bearing of these facts appears to be on the question of the necessity or otherwise of big game to the well-being of the fly, and the following article aims at an examination of this question in the light of the information at our disposal in this part of the insect's range. It may be stated at once that the case built up is considered strongly in favour of a vital association between the prevalence of big game and the continuance and increase of the fly.

First of all, some remarks are necessary concerning the most direct method of collecting evidence as to the association between tsetse and big game, namely, observations on the prevalence or otherwise of big game in areas infested with fly. During the last four and a-half years the writer has visited the great majority of the fly-belts in the territory, and the main belts repeatedly, and, broadly expressed, the results of observations on game and fly are to the effect that in most cases game is more or less abundant all the year round in fly-infested country, and that in no instance is the larger animal life altogether absent, even during a portion of the year. The most noteworthy locality where fly occurs in abundance and big game is scarce towards the end of the dry season is below the escarpment in the Lomagundi district, in the triangle formed by the Hanyani and the Ambi Rivers with the Rukowakuona Mountains (the escparment). The Dande and Ambi rivers and their tributary streams contain no surface water in October and November, the few natives living on the Dande obtaining water at this period by digging holes in the bed of the river. The little Gorai River is a tributary of the Dande and a well-known haunt of tsetse.

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The point where the writer carried out certain investigations on this watercourse is fifteen miles away from the Hanyani, the nearest open water at the end of the dry season. The grass is burnt off annually by the natives, and the game naturally forsakes country which contains neither grass nor water. Along the banks of the Gorai, nevertheless, fly is abundant in October and November, whilst on the west bank of the Hanyani, where the game is normally abundant at this time of year, fly is scarce. This appears at first sight a strong argument for the disassociation of tsetse and big game, but closer investigation of the situation reveals the presence of other factors.

In the first place, the situation as seen in October and November is only temporary, being due to the drying up of the rivers and the burning of the grass. In the second place, although at the time of the visit the larger antelopes had all deserted this part of the country, there were left behind two species of animals undoubtedly capable of yielding sustenance to tsetse, namely warthog and duiker, of which the former appears to the writer to be the more important, from the fact that shot specimens are frequently found abundantly attended by the fly, and that trypanosomes have been found in warthog blood (Bevan, inter alios). These animals either have the power of burrowing down to water where other animals would have to thirst, or are constitutionally to a large extent independent of drinking, because they are, like the duiker, met with in very dry tracts of country where none of the larger antelopes are to be found. Along the Gorai River, in November 1911, the writer saw several herds of warthog, and one herd was lying on the very river bank in the shade where the tsetse congregate, and was probably affording a meal to numerous tsetse at the time. There was also evidence of much rooting in the vicinity of the river where the ground is soft and succulent roots are more abundant than in the neighbouring bush. In the third place, the fact of the tsetse not being found associated with the game at the Hanyani river is probably accounted for by the nature of the country. Along the Hanyani where the game was congregated the banks of the river are very thickly wooded and there is much very dense undergrowth, whilst this condition gives way to country in which shade is very deficient. Now shade is essential to tsetse, but *G. morsitans* is not, in the writer's experience, found in abundance in this territory in any bush so tangled as to be difficult of penetration. In addition to this, the neighbouring forest is unusually open, not affording much shade even in the wet season when tsetse spreads through the bush instead of remaining confined to the shady banks of watercourses and edges of vleis. The Gorai River affords excellent winter shade, and the surrounding bush is sufficiently shady during the rains, so that it is in all respects suitable for tsetse, and it is not a matter for wonder that the fly has increased and made its home in this part, whilst it has failed to do so to the same extent on that part of the Hanyani river to which reference has been made. In April 1911, the writer again visited the neighbourhood of the Gorai River and found that game, including rhinoceros, zebra, sable, kudu, eland, impala, etc., was moderately abundant in the haunts of the tsetse, which was at that time to be met with throughout the bush.

The foregoing argument has been set out in some detail in an endeavour to demonstrate that opinions formed in passing through a certain locality at one season of the year are liable to serious error, and that too much weight should not therefore

be attached to such observations. Whilst aware that considerable evidence has been brought forward to show that in other parts of Africa tsetse may occur in abundance where no big game is found at any season, the writer is forced to deal only with Southern Rhodesia, where no such instances have come under observation.

Turning now to broader considerations, the evidence in favour of the necessity of big game to the tsetse in Southern Rhodesia and adjacent territory may be summed up under four heads :—

(1) Tsetse retired before the advance of civilisation in the Transvaal, the only known modification of conditions being the destruction of the game.

(2) Tsetse disappeared from large tracts of country immediately after the rinderpest epizootic in 1896.

(3) Tsetse has increased and spread since the rinderpest only in those parts of Southern Rhodesia where big game has increased.

(4) Tsetse has greatly decreased of late years in the Hartley district in those parts where the big game has been most effectively destroyed or driven away.

Concerning (1) the writer must confess to the opinion that sufficient weight has hardly been attached to the phenomenon of the retirement of the tsetse before the advance of the white man, for in conjunction with subsequent events in this territory and elsewhere, this is one of the most weighty arguments for the vital association of the fly with big game. The advance of settlement was preceded by the wholesale destruction and driving away of the larger fauna of the forest, *and for many years this was the sole modification of natural conditions due to the advent of the European.* The only attempt at a suggestion of other changes that might conceivably have had an adverse effect on the tsetse appears to be that settlement implies a certain amount of clearing of the forest, but it is quite obvious that settlement did not penetrate into fly-infested country, but pushed the pest back before it; that is to say, that farms were not worked "in the fly," for very natural reasons, and that therefore, as a general rule, no clearing of any extent occurred in the forest until the fly had practically disappeared from it. As a matter of fact but little clearing usually occurs on pioneer farms in South Africa for many years after occupation, unless the farmer happens to be a man of considerable substance and enterprise, bent on developing his farm agriculturally, attributes hardly characteristic of the voor-trekkers in the Transvaal, who were primarily stock-owners. Where could farmers find a market for great quantities of agricultural produce in those remote undeveloped parts?

To pass on to (2), the total disappearance of the fly from some parts of Africa and its great reduction in others after destruction of the bulk of the game by rinderpest is, of course, a very strong argument for the dependence of the fly on game, but the fact is so notorious that its force in connexion with the subject of this paper calls for no particular comment. In Southern Rhodesia the pest has never reappeared in certain localities. There is no tsetse now on the Limpopo and Sabi Rivers within the Rhodesian borders; there is none in the Bulalima-Mangwe and Bubi districts, near Selukwe in the Gwelo district, along the Zambesi near the Victoria Falls, or in the Wankies district, in all of which it used to occur in varying abundance according to the reports of early hunters and traders. (The areas coloured blue in Map I have been mainly drawn from the writings quoted in Austen's "Monograph of the Tsetse Flies," with additions obtained from other sources, or copied from

Austen's map, and shew roughly the parts from which the tsetse disappeared altogether after 1896).* In other areas a nucleus of the pest was left, but large tracts of country were free which are infested at the present time. On the authority of Lieut. R. W. Thornton of the B.S.A. Police, who has probably a better personal knowledge of the Lomagundi district than anyone else in the Territory, fly was hardly taken into consideration there until the year 1902, horses being taken freely all over the district. According to Mr. Herrington of Sipolilo, and formerly of the B.S.A. Police, and certain cattlemen questioned personally, fly was first encountered on the cattle route south of the Zambesi in 1902. The path by which the cattle are brought down crosses the Zambesi at Feira and the Hanyani river about six miles below the escarpment. It was between that river and the escarpment that the fly appeared. According to native testimony, however, tsetse existed earlier than this to the east, about the Gorai River already mentioned, but very definite information is lacking. After 1902 the spread of the pest was rapid,.and by 1905 at least it extended as far north as the junction of the Ambi River with the Hanyani. Mr. Herrington, who, on account of possessing a store near the cattle route, has always received regular information from the cattlemen, states that the fly first appeared between the Hanyani and Angwa Rivers in 1907. It is now found on the Angwa, but not in very great numbers.

A great belt also exists to the west of the Angwa, between the escarpment and the Zambesi, and practically joins up with the belt just mentioned. It seems probable however, that it has spread from a nucleus within itself since the rinderpest, but European testimony on this point is not available.

The situation in the Lomagundi district has some special features of its own. The available information concerning this district before 1900 is more meagre than in regard to any other. There appears to be no record of tsetse at that time in the neighbourhood of Tchetchenini Hill, but Mr. Herrington states that it was fairly numerous there in 1903. It is probable, therefore, that a nucleus of fly remained in this part after the rinderpest.† Whether fly was present below the escarpment to the north-west of the district at that time can only be conjectured. There is no doubt, however, that that belt has extended very greatly of recent years. The present

* [As it might be inferred from this statement that fly was present in all the areas coloured blue in Map I up till the rinderpest, it is well to explain that this was by no means the case. As regards the large blue area to the north of the Limpopo, the writer traversed the eastern quarter of this in 1893, being camped for ten days on the north bank of the Limpopo, and there was certainly no fly then anywhere near the Old Hunters' Road, along which waggons were frequently passing. Mr. F. C. Selous, who has examined Mr. Jack's map, has expressed his conviction that there was no fly in any part of this area in 1896; though it existed to the east of the Nuanetsi River and at the junction of the Shashi and Shashani Rivers—areas not indicated on the map. Similarly, he can assert that the fly-belt shown to the west of the Victoria Falls had disappeared by 1888, and is of opinion that much of the fly to the east of the Falls had also gone by that date. He has never known fly to occur in the Ramakwabane area shown in the map since he first went there in 1872. There are various well authenticated cases of the disappearance of fly before any wholesale destruction of game, but Mr. Jack admittedly does not attempt to deal with that aspect of the question. (*Cf.* Stevenson Hamilton, Bull. Ent. Res. ii, 1911, pp. 113–116).—Ed.]

† Since writing these notes the writer has received indirect native testimony to the effect that tsetse never died out altogether in the neighbourhood of Tchetchenini Hill after the rinderpest.

delimitation of the area there is due to Dr. Stohr, of the Northern Rhodesian service, who visited that part early last year (1913). The strangest feature of the situation, however, is presented by the country south of the escarpment and to the west of the Angwa river. Between 1905 and 1910 odd specimens of fly were encountered at a number of isolated spots in this area. Such spots are coloured yellow in Map I. There is no doubt about the reliability of these reports; they are mostly due to Thornton, who is perfectly familiar with tsetse. A few are due to native messengers who brought specimens to the Native Commissioner's camp. Subsequent visitors have almost always failed to find fly at any of these spots; the Native Commissioner for Lomagundi and Dr. Stohr both failed at different times to find or hear of any fly about the Piriwiri, Susenje and other rivers to the west and south-west of Sinoia; Mr. C. W. Howard and the writer failed to find any on the Ingonya river in 1909. Dr. Stohr failed to find any on the Naodza and other rivers further north early last year; he refers to the matter in his report as follows:—"Whatever fly there may be in the Urungwe sub-district, outside of the Zambesi Valley, must certainly be very scarce and scattered. I found none and could hear of none from natives."

This part of the country has been shot over to a considerable extent by hunters and prospectors, but the game has certainly not been reduced to anything like the same extent as it has in the Suri-suri belt in the Hartley district (to be dealt with shortly). There appears to have been no fixed belt of any extent in this part since the rinderpest. It should be mentioned that, according to Mr. Herrington, a party of police reported a belt seven miles wide on the path from Sinoia to Urungwe in July 1898, but this has never been confirmed, and according to Thornton's statement the police apparently had not accepted the report as reliable. The belt is certainly not in existence at the present day. No explanation of the phenomenon can be attempted. It would seem that the fly in this part survived the rinderpest in very small numbers in scattered localities, failed to increase to any extent, but persisted until recent years, although on the verge of extermination. Concerning the factors controlling the situation we are altogether ignorant.

Our information in regard to the belts in the Sebungwe district up to 1910 is due almost entirely to Mr. Val. Gielgud, formerly Native Commissioner for the district. Mr. Gielgud states that west of the Sengwa River in the years following 1896 the fly was only to be found in the neighbourhood of Manzituba (see Map II). The country lying between the Sengwa and Umniati (Sanyati) Rivers was formerly known as the Mafungabusi district, but has now been merged into the Sebungwe district. Concerning this portion the available information is somewhat indefinite as regards boundaries, but all reports agree that no fly existed to the Sengwa side, and that a belt always existed along the Umniati river, which has, however, only extended to its present limits within recent years. The writer has personally noted a southward extension of about seven miles since November 1910, and according to the testimony of white hunters and natives there has been a considerable progression to the north and west.

Owing to the native disturbances and other troubles which affected Southern Rhodesia in 1896–7 and the undeveloped state of the country, exact information concerning the distribution of tsetse between that time and the year 1900 cannot be expected. The areas coloured red in Map I give a general idea of the country infested

at the time, and are probably as approximately correct as they can be made at this late date. By comparing the red areas with those coloured green, which represent the range of the fly at the present time, the extent to which the pest has spread since the rinderpest can be realised.

Our information concerning the spread of tsetse in the Sebungwe district is more detailed than it is in regard to other parts. In 1907, Mr. Gielgud submitted a map showing how the fly-belts had extended up to that time, and the writer has since been able to supplement these observations. In this way the material for Map II has been collected. This map shows the limits of the fly after 1896 (red), in 1904 (blue), in 1907 (brown), in 1910 (yellow), and at the present day (green). In regard to the limits for 1910, it should be noted that the line drawn from the southernmost point to the junction of the Busi River with the Sengwa is to some extent hypothetical. Tsetse was first taken on the Sengwa in that year at the junction with the above-mentioned river, and the writer fixed the southern boundary in May. The southward movement of the fly had been very rapid, and had driven away the only native chief possessing cattle in the district. This was Pashu, whose old kraal is shown on the Mlendi river on the map. This native subsequently moved his cattle back to his old kraal and lost very heavily from trypanosomiasis, whilst some Government mules stationed at a kraal within three miles of the same spot also died about the same time. The present day boundaries have been fixed with some degree of accuracy, but waterless stretches of country have had to be crossed by hypothetical lines. The isolated belt on the lower Sengwa was discovered last year (1913). It is situated in rough uninhabited country, and may have been overlooked for some years. The fly is very thick at one spot close to the Sengwa in this belt.

The Sebungwe area is of special interest because, apart from the three officers of the Native Department until last year stationed at Kariyangwe, there have been no white men living in the district to the west of the Sengwa river, the natives are practically unarmed, and the processes of nature have not been interfered with by human agency. Big game has increased greatly and is now very abundant in certain parts.

Turning now to the Hartley district we are confronted with an exactly opposite situation. Here human agency has been at work for years and natural conditions have been modified. The heart of the fly-belt on the railway line, which is the one to which it is desired to call particular attention, is about the head-waters of the tributaries of the Suri-suri river. It is, in fact, usually known as the Suri-suri belt. There is, unfortunately, but little to be learnt from a comparison between the extent of the belt after 1896 and its extent to-day, because it is nearly surrounded by mines, and although the heart of the belt was, up to 1912, still virgin forest, the bush had been cut down to supply fuel and timber to a considerable extent around it, and conclusions, therefore, cannot be drawn from the fact that the fly has not spread widely in the district. It may, perhaps, be worth noting that, in spite of the facts mentioned above, there have always been channels some miles in breadth along which the pest might have spread without encountering any modification of its native habitat beyond the scarcity of game. On the whole, however, it seems best to leave this side of the matter out of the question. It should, moreover, be noted that owing to the large number of cattle used for transport on the mines and farms, our information concerning the range of the pest in these parts is exceedingly good, and that the portion of the

district coloured green in Map I includes all localities where cases of trypanosomiasis have occurred during the past five years, whilst in other parts of the territory only areas in which tsetse have been actually seen have been marked. One might live for months within certain parts of this green area and never see a tsetse-fly, in fact the only place where specimens can be expected is in the heart of the belt, which is coloured red. In spite of farming and mining operations, however, there was, until early last year (1913), an area about 150 square miles in extent in which the only change from natural conditions due to human agency had been the destruction and driving away of the game. During the past few months a light railway has been run down to the heart of the belt to supply timber for certain mines near Gatooma, and, according to information received, the destruction of the forest has been very considerable. Events subsequent to 1913, therefore, have no bearing on the question of fly and game.

An area embracing the fly-belts in the Hartley district was first thrown open to free shooting for three months in the year 1901, but this period was not extended. Later, in 1905, the Game Laws were again suspended in respect to this part of the country, zebra, elephant, rhinoceros, hippopotamus and ostrich being excluded, however, from the scope of the notice. The open area was maintained until 1908, but in that year was closed again, only to be reopened in 1909 on account of heavy losses amongst cattle. Since that time the Game Laws have remained suspended with respect to the fly-infested portion of the district.

The basin of the Suri-suri River, being easy of access, was shot over to a great extent by residents in the district, as well as by professional hunters, and between 1905 and 1908 a considerable reduction of the game took place. But even in 1909 there were still small herds of eland, sable, zebra and other buck to be met with, as the writer is able to testify. The destruction has continued since then, and at the present time the basin of the river, once one of the more prolific hunting grounds in the territory, is almost destitute of the larger fauna, although until last year a few still lingered, and small herds were liable to pass through at certain seasons. A few warthog and small buck were usually to be found. The writer visited this part first in August 1909, and there was considerably more evidence of big game at that time than in the years following.

The last instance of tsetse having been met with in considerable numbers in the Suri-suri belt occurred in 1908, when Dr. Alex. Mackenzie, of Hartley, found the pest sufficiently thick to constitute a serious personal nuisance, and his statement is borne out by Mr. L. E. W. Bevan, Veterinary Bacteriologist, who was with him at the time. Other testimony from both European and native sources agrees on the point that the fly was more numerous previous to 1909 than afterwards. In 1910, a Cape boy who drove the writer to the point where the little-used road from Hartley to the Golden Valley Mine crosses the Suri-suri River near its head-waters volunteered the statement that a few years previously the mules would have been attacked by a swarm of tsetse at this point. The very considerable losses of cattle from trypanosomiasis at the end of 1908 and the beginning of 1909 were, as stated above, largely the cause of the area being again thrown open to free shooting in March of the latter year.

The writer paid almost monthly visits to the Suri-suri belt after August 1909, and throughout 1910, and never on any occasion met with the pest in numbers. The greatest number seen in one day was in October 1909, when the total was nine. Usually

two or three were encountered, and occasionally none at all. The belt has been kept under observation since, and there has been no sign of increase. Losses from trypanosomiasis in cattle have decreased in this part of the district; in fact, until a contractor, presumably emboldened by the general immunity, actually kept and worked his spans in the very heart of the fly-belt, they had nearly ceased, and cattle are now kept and worked where it would have been fatal to have done so formerly. Tsetse has not, however, altogether disappeared. The last specimens submitted to the Department of Agriculture were taken by a farmer in August 1912, and Dr. Mackenzie, of Hartley, reported having encountered a small patch on the Hartley-Golden Valley road the following November. The cases of trypanosomiasis amongst the cattle working in the heart of the old fly-belt indicate that a few tsetse are still to be met with. The presence of cattle in the former haunts of the game, where fly still persists in very small numbers, might conceivably have even caused a small increase of the pest since last year, though the clearing of the bush would eventually counteract any tendency of this nature.

The lingering of the fly does not, of course, affect the broad facts of the situation, seeing that the game had not been altogether destroyed. The important fact is that in this district alone in Southern Rhodesia has tsetse decidedly decreased of late years, and here the game has been greatly reduced by artificial means. In other districts where permanent fly-belts occur the game has become more abundant and the fly has increased and extended its range greatly since 1896. It is interesting also to note that the greatest and most rapid extension has occurred in those parts of the territory where game is most abundant, as in the Sebungwe district and certain parts of the Zambesi Valley.

We have, therefore, south of the Zambesi River a very logical chain of evidence, so far as it goes, suggesting the necessity of big game to the tsetse-fly, namely, the retirement of the fly before civilisation under circumstances difficult to dissociate from the effect of game destruction, the general disappearance or great reduction of the fly coincident with the general reduction of the game by rinderpest, the increase and spread of the fly again corresponding with the increase of the game, and, finally, the reduction again of the fly locally coincident with the removal of the game by human agency in that particular spot.

The writer is well aware that something more than these facts will be required before the theory of the vital connexion of the two forms of life is accepted, especially as some contradictory evidence has been brought forward elsewhere. On account of the nature of the problem, however, final proof could only be constituted of an accumulation of circumstantial evidence pointing in the same direction, and the Hartley experiment in this territory appears to be the first definite effort to obtain direct evidence on the point. The experiment was not carried out with the scientific detail that would undoubtedly have rendered it more valuable, but nevertheless the result is very significant in conjunction with events elsewhere. At the present time it may be said that nearly all the known facts in South Africa either strongly support the positive theory or are, at any rate, not inconsistent with it. Years before the rinderpest epizootic it was the general opinion amongst hunters (*vide* quotations in Austen's "Monograph of the Tsetse Flies") that "the fly would disappear with the game." The apparent effect of the rinderpest was confirmatory to an amazing degree,

and subsequent events have now lent their support. Even to suggest any other possible explanation of the various phenomena is a matter of difficulty and necessitates an appeal to the possibilities of coincidence that few would care to place upon paper.

Apart from the contradictory reports of different observers, the great obstacle to the acceptance of the theory of the necessity of big game to the tsetse-fly is the fact that many other possible sources of blood than the ungulate mammals exist in the African forests. By a closer examination of the matter, however, it seems probable that the vast bulk of these are not fitted to be relied upon in this respect. Few will contend that there is any possibility of invertebrate animals, such as caterpillars, being a permanent source of nourishment to the tsetse. Amongst the vertebrata it also appears from the researches of Kleine, Roubaud and others, that an exclusive diet of reptilian or amphibian blood, or even a mixed diet of such blood and that of mammals, is deleterious to the species.* As a matter of fact in the case of *G. morsitans* such a supply is rarely available, as the fly is not often found on the banks of the larger rivers where crocodiles abound, and the belts in the dry season are frequently far removed from water of any sort, in which case water-loving reptiles, such as *Varanus* and freshwater Chelonia, as well as most amphibians, are not available. The smaller lizards, including chameleons, are more likely to make a meal of tsetse than *vice versa*, whilst the terrestial tortoises are too scarce to be of any account. Amongst the mammals, certain orders, namely the Insectivora, Chiroptera and Edentata, are obviously of no service on account of their nocturnal habits and the seclusion of their diurnal retreats. Certain rodents, such as hares, may serve the fly for a meal on occasions, but the order can be of but little importance on account of the small size and activity of the majority of its members and the fact that they are largely nocturnal in habit. Of the larger species the porcupine (*Hystrix*) is entirely nocturnal, but certain squirrels attain a size not greatly inferior to that of a rabbit and are of diurnal habit. The larger forms of the latter family are, however, rarely seen in country suited to the tsetse. No doubt the larger Carnivora are attacked by tsetse when they enter its haunts, but their numbers are relatively so small that they are practically negligible. Lions and, to a lesser extent, hyaenas, are also dependent on the larger ungulates for food, and desert country from which these have been driven. The hunting dog (*Lycaon*) is always migratory, and leopards and jackals, in addition to their scarcity, lie up during the day. The smaller Carnivora—FELIDAE, VIVERRIDAE, MUSTELIDAE—are also practically nocturnal, and from their alert and active habits are unlikely to submit to be fed upon. Anyone may note the intolerance of the domestic cat to the attentions of *Stomoxys* in this connexion. It would seem, therefore, that the whole class of Mammalia, with the exception of ungulates and certain primates, are little fitted to be of service to tsetse even in the aggregate. The smaller antelopes and Quadrumana must be considered later. In connexion with birds, we are faced with the fact that tsetse certainly shows no dislike to avian blood, as fowls have been freely used to feed the flies (both *palpalis* and *morsitans*) in confinement, and evidence has been brought forward to show that species of *Glossina* at least occasionally secure a meal from certain birds in nature. On the other hand,

* [The researches referred to concerned *G. palpalis* and not *G. morsitans*; moreover, the later observations of Duke, Carpenter and Fiske indicate that the conclusions cited are probably erroneous, for they have found reptiles to be a highly favoured source of food for *G. palpalis* under natural conditions.—ED.]

in the case of *palpalis*, Koch has shown that, in the presence of other sources of blood, birds are not laid under contribution to any great extent, and his observations have been confirmed by Bruce. Similar observations do not seem to have been made with *morsitans*, but it should be noted that this species has little opportunity of feeding upon the quiescent water-loving birds suggested as the source of the avian blood found in *palpalis*. Moreover, the tsetse's habit of awaiting its prey not far from the ground renders it probable that the vast majority of birds come comparatively rarely within the ken of the fly.* Small birds, also, in addition to their restlessness, activity and tendency to catch insects, probably have but little power of attracting tsetse, for there is some evidence to show that the size of an animal and the amount of disturbance created in moving about have a direct influence on the number of tsetse attracted, at least in the case of *morsitans*. It would in fact seem that the distance a tsetse is led by scent alone is a comparatively short one. The writer has frequently had the experience that when sitting quietly in a fly-belt few tsetse would be in attendance, but that a movement of only a few yards brought a considerable accession of numbers, the newcomers showing a desire to bite that proved they were hungry. On the other hand, movement through infested forest invariably attracts a number of the flies, even when it is as soundless as progress along a path on a bicycle. The flies in such circumstances do not always evince a desire to feed, but on the other hand they quite commonly do so. From this it appears that the range of sight is greater than that of scent, and that large moving bodies constitute a particular attraction. If this is the main method by which flies are attracted, the range of attraction of an animal should, within certain limits, vary in direct ratio with its size, and one can understand that, apart from all other considerations, small mammals, small birds and small reptiles could on this account alone form only a casual source of sustenance. There are, however, certain birds which live almost entirely on the ground, are of sufficient size to attract tsetse from some distance by vision, and are often found in great abundance in the particular haunts of the fly. These comprise several species known as game birds, and include *Numida*, *Pternistes*, *Francolinus* and others. The fact of tsetse feeding on fowls in captivity would seem to show that attempts would be made to feed on other gallinaceous birds in a state of nature, at least when pressed by hunger. The writer has, nevertheless, found on entering a limited belt where enormous numbers of game birds were congregated, the flies were as eager for mammalian blood as elsewhere, and the collapsed state of the abdomen showed that they had not fed to the full for days. At this spot the birds rose from the grass at almost every step, and if the flies were in the habit of finding the birds and feeding on them there was certainly not the least difficulty in every fly doing so, nor any apparent reason for the presence of swarms of desperately hungry individuals. There is therefore some ground for belief that for some constitutional cause, such as their conformation, their armature of feathers, their activity, their habit of pecking at insects, or such causes combined, birds as a class do not form a very suitable source of sustenance to tsetse.† That some such disability exists in respect to most other

* [In a series of captured *G. morsitans* examined by Lloyd in Northern Rhodesia, he found that of the specimens in which the blood content could be identified 15 per cent. contained non-mammalian blood.—Ed.]

† On admittedly somewhat slender grounds Mr. Lloyd, of the Luangwa Sleeping Sickness Commission, is inclined to the belief that *morsitans* does not thrive on avian blood in the same way as it does on mammalian.—*Bull. Ent. Research*, iii, part 3.

bloodsucking flies would seem to be beyond question, when we consider how little attention *Stomoxys*, *Haematopota*, *Tabanus*, etc., pay to fowls, for instance, even in the absence of larger animals. The only bloodsucking flies that have made a thorough success of feeding on birds appear to be some members of the HIPPOBOSCIDAE, which have developed a parasitic habit and become specially adapted to moving about amongst feathers. The flat form of *Olfersia* is obviously of advantage to it in this respect, and we can see how ill-adapted the tsetse is in comparison.

With regard to the smaller antelopes and Quadrumana there is no doubt at all that the fly feeds upon these animals whenever appetite and opportunity coincide, or that a regular supply of the blood of these species would serve the fly indefinitely. The small buck, such as *Cervicapra* and *Cephalophus*, however, do not run in herds and are very scattered, and on this account are not fitted to afford a regular meal to large quantities of tsetse. It is conceivable that monkeys and baboons, in spite of the great troops of the latter, also fail to some extent in this respect. They are also by no means constant denizens of fly-belts.*

A feasible explanation of the dependence of *G. morsitans* on the larger Ungulata seems to be that a regular supply of blood is essential to the continuance of the fly, and that this is only afforded by the presence during the greater part of the year of these grass-feeding animals. An irregular supply is afforded by monkeys, baboons, small buck and other animals, and possibly birds, which may help to tide the insect over periods of scarcity. It does not appear to be incomprehensible that a regular supply of food should be of such importance to the species when we recollect the great expenditure of substance of the female in the comparatively slow process of reproduction. The tsetse is obviously very delicately poised in the balance of nature, and any retardation of the rate of reproduction would obviously have a tendency to result in the failure of the species to maintain itself. When food is scarce there is no doubt that reproduction is retarded, and in belts where a season of scarcity occurs annually there will be comparatively few offspring produced during certain seasons of the year. The very few pupae found by the writer on the thickly infested Gorai River supports this view, especially when compared with the results obtained elsewhere in belts not subjected to annual periods of dearth. During a portion of the time when the flies are congregated in the shade provided by the banks of the watercourses reproduction is apparently very slow, and it must be assumed that the numbers of the tsetse are maintained by the breeding which occurs at other times of the year. Where, by the removal of the main source of food, tsetse is subjected permanently to an irregular supply and also forced to draw this from sources involving some danger to the fly itself, reproduction could quite conceivably fail to keep pace with the death rate, and the species die out on this account.

The writer would emphasise the fact that no claim is made to have explained in the foregoing pages all the phenomena connected with the disappearance of tsetse-fly. There are far too many factors affecting the situation. Nor does he hesitate to admit, first, that there are many abler students who could have handled the subject with far more knowledge and dexterity than himself; and secondly, that many of his

* Dr. R. E. McConnell's observations on the actions of his pet monkeys when attacked by tsetse show that making a meal of monkey's blood is not without danger to the fly itself. In connexion with a species to which the prolonged survival of the individual is of such importance as it is for *Glossina*, this may not be without significance.

deductions are tentative rather than conclusive. The sole object in view has been to point out that the apparent dependence of *G. morsitans* on big game is not quite such an inexplicable phenomenon as it appears to be at first sight. The position of tsetse-fly at the present time, in fact, would suggest some such dependence.

A further experiment in the direction of ascertaining whether the spread of tsetse can be checked by the reduction of big game has now been commenced in the Sebungwe district. A wide belt of country, bounded on one side by the Umniati River and on the other by the Sengwa, has been declared an open area for shooting. The open area embraces the fly-belts shown in Map I between these rivers. The fly is reported to be spreading across this area from the west and east, and it is desired to prevent the two belts meeting and embracing the Bumi and Sesame rivers where there is a considerable number of native kraals. Observations have been made on the limits and abundance of the tsetse, and, provided that the suspension of the game laws results in the destruction of the big game to a sufficient extent, the experiment should certainly yield valuable information.

There is one side of the question which has not been touched upon, namely, the theory of a special association between tsetse-fly and buffalo. It is urged by those who support this theory that it was the nearly complete extermination of the buffalo, apart from other game, by the rinderpest that was the cause of the great reduction of fly which immediately followed. If this theory is still tenable, it must now be urged that the increase of fly has been due to the increase of this species of animal, unless, of course, it is suggested that the progeny of the fly that survived the year 1896 have acquired new habits, which would be merely a method of admitting that the theory no longer holds. Whatever may have been the position before the rinderpest—and buffalo blood may have been the most easily obtainable food of tsetse at that time—it is quite certain that in Southern Rhodesia to-day the fly is not in any way dependent upon this species of animal. Buffalo was at one time, as is well known, extremely abundant in various parts of the territory, but whatever may be the reason* its numbers have not increased since the rinderpest in the same proportion as the various species of antelopes. This may be due to the fact that the reduction of the buffalo was more nearly complete than that of any species of antelope, or to some other cause; but at the present time buffalo is not generally met with throughout the territory. Herds occur in certain parts, but as a species it is distinctly local. Were buffalo of vital importance to tsetse, herds would occur in some abundance throughout the fly-infested country; but, as a matter of fact, there are great belts of country infested with fly in which buffalo is rarely or never heard of, as in the greater part of the Sebungwe belt lying west of the Sengwa river, the biggest and most thickly infested fly-area in this territory. Buffalo does occur in parts of this belt, as on the lower reaches of the Busi River, where tsetse is reported to be very thick indeed. In October 1912, also, the writer saw traces of a small herd at Manzituba, but this is not a haunt of the animal, and there is little doubt that the herd was only passing through, probably towards the Busi. The writer could find no traces of buffalo at this spot in the previous year and could obtain no information of its occurrence there from either white men or natives. There is also a herd on the Gadzi River, near its junction with the Sesame, where fly is present in small quantity only. Buffalo

* The species has never been protected under the Game Laws.

also occurs in the fly-belt to the north of Tchetchenini Hill in the Lomagundi district, where fly is not particularly numerous, and another herd is reported to keep to the west of the Hanyani River below the escarpment, where fly is decidedly scarce, especially in the dry season. To the north of the Hartley district buffalo is found near the Yabongwe River, where fly also occurs, but in no great numbers at the time of the writer's visit in November 1911. In no other parts of the territory has the writer been able to find traces of buffalo inhabiting the same stretch of country as tsetse, but there is evidence that instances occur in the north-west of the Lomagundi district, a part not yet personally visited. In Map I a black cross has been made at the spots where buffalo is known to occur within or close to fly-infested country. It is instructive to note that in the one spot where the fly in the Sebungwe district appears to have found the most favourable channel along which to spread at the present time buffalo is by all accounts absent. This is the Lutope River, up which the fly certainly extended rapidly during the past few years. The writer visited this river in October last year (1913) and met a hunter who had also been to this part in 1912 and previously. This hunter stated that the fly had moved about twelve miles up the river since 1912, but too much weight should not be attached to the accuracy of this figure. That the pest had moved rapidly up the river appears, nevertheless, to be certain, as some natives who were being moved out of infested country on account of the sleeping sickness chose this part for their future habitation, and were astonished to find last year (1913) that fly was present in abundance in country which they had considered free. With regard to the absence of buffalo, the natives, native police, hunting "boys," the Government officials at Gokwe (the present head-quarters of the Native Commissioner for the district, recently moved from Kariyangwe) and white hunters were all agreed on this point.

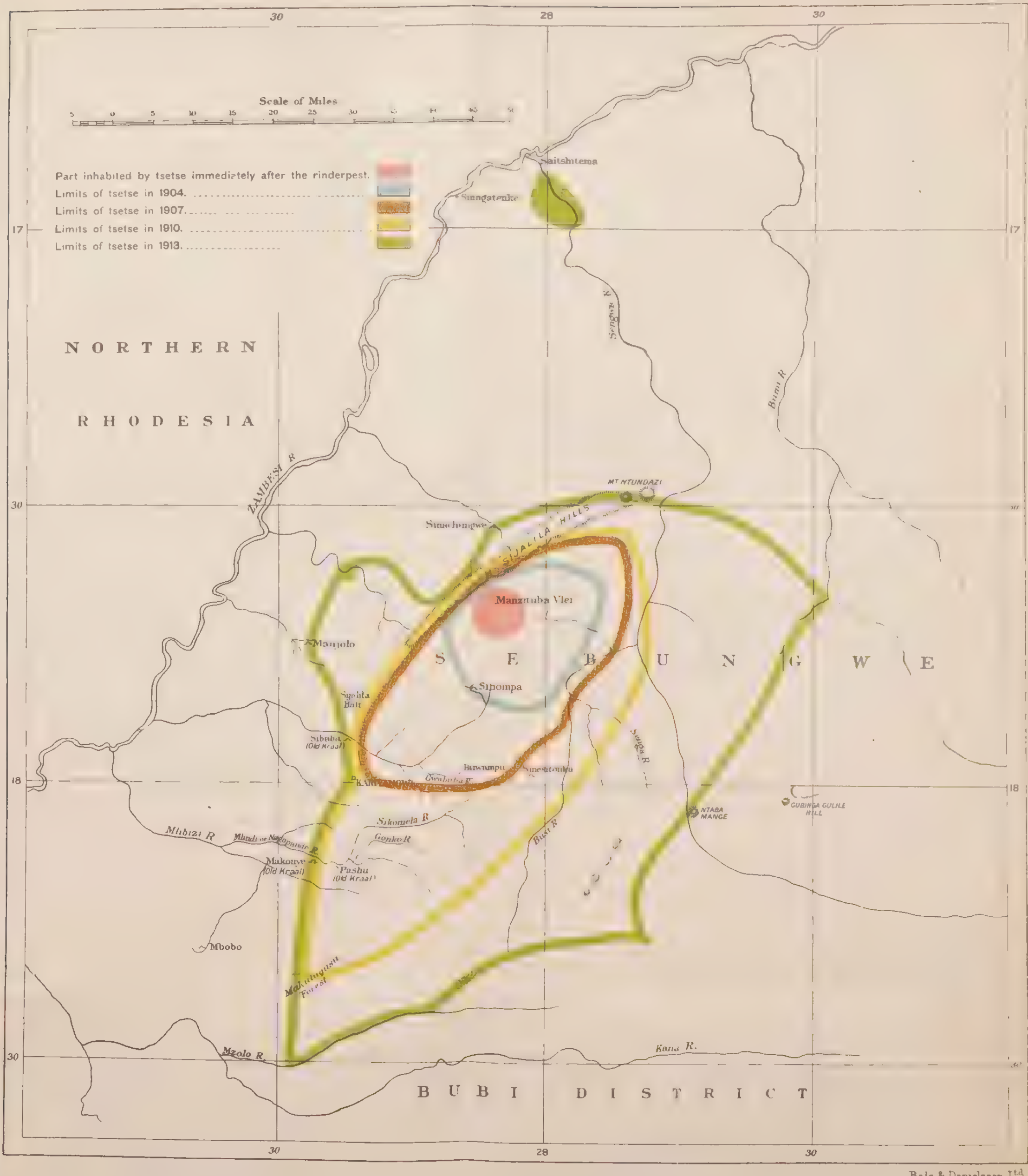
The converse argument is of little importance, but one hears so much about fly following the buffalo that a very striking instance to the contrary may be recorded. Near Nenyunka's kraal on the Sengwa River there is a thick thorn brake, such as is termed isi-nanga by the natives, in which buffalo is very abundant, far more so than any other species of game in the vicinity, but tsetse is not to be found. The writer's companion on a recent expedition, Mr. Ernest Ritter, had spent a week at this spot without seeing any tsetse, although keeping a constant watch for them. The writer, in company with Mr. Ritter, penetrated to the heart of the isi-nanga where the drinking places of the animals were situated and where the quantity of dung made the place look like a cattle kraal, and met with no fly. Nenyunka's kraal is certainly marked on the edge of the fly-area in a recent map of the district, but this was on the strength of one or two having been reported to have been seen by natives. The edge of the belt to the south is, on reliable information, from ten to fourteen miles up the Sengwa from this point, and there is another belt on the lower reaches of the Sengwa, the limits of which have not been clearly defined, but here, in the very haunt of the buffalo, fly is absent.

To sum up the matter rather baldly, it is quite certain that no one having travelled through the fly-belts in Southern Rhodesia, as the writer has done done during the past five years, could entertain the idea that, except in a few localities, the blood of the buffalo is, even at long intervals, a regular food for the tsetse, much less that it is an essential one.

A few words are necessary in connexion with the maps attached to the article. It should be noted that the maps of certain of the more remote districts of the territory have been compiled from sketches alone, and that in the Sebungwe district there is not a single fixed point to act as a base. This explains the discrepancies in recent maps of this district which have been attached to reports. The map has been constantly in a process of correction and is still far from accurate. During a recent expedition to the district the writer devoted what available time he had to corrrecting distances and directions, and took a large number of angles with a theodolite. It was, however, found impossible in the circumstances to connect these with any fixed points, and as a consequence the map of the district (Map II), although believed to be a considerable improvement on previous sketches, is patchy, the old map having to be altered to fit in with the new, and certainly contains many inaccuracies. The map of the district as shown in Map I is drawn from the older sketches and the errors are still greater.

It should also be borne in mind that maps of the distribution of fly cannot be made very accurate. During the latter part of the dry season tsetse is only met with along the shady banks of watercourses and vleis, but during the rains it spreads for several miles through the surrounding bush. Most of the mapping is done in the dry season, and a difference of a few miles is quite noticeable in a map drawn to the scale of five miles to one inch. Again, the "following distance" of the fly is probably not far short of ten miles, and may be more in extreme cases, and this obviously introduces another element of inexactitude. It is quite impossible to obtain an approximate delimitation of a belt by working from within. In such circumstances it is necessary to proceed further until clear of the fly and later to strike back until it is encountered again, and at least a day should elapse before this is done. Finally, whilst the limits of a belt along a river are never definable within a mile or two, if natives are constantly passing up and down the limits are still more elastic, and fly, having been carried by natives, may be encountered one day 6 to 7 miles beyond the point where a visit the next day would place the border. These remarks seem necessary because the early hunters have insisted so strongly upon the sharp delimitation of fly-belts. Areas infested with *G. morsitans* are only sharply delimited in the writer's experience roughly between July and December, when the fly is confined to the shade along rivers (dry or otherwise) and vleis, and even then the boundaries along the rivers are somewhat elastic. When the bulk of the bush is shady they shew no preference for their dry season haunts, occurring freely in the surrounding mopani belts and "gusu" bush, that is, open forest consisting usually of species of *Brachystegia* with little or no undergrowth.

Map showing the changes in the distribution of GLOSSINA MORSITANS in Southern Rhodesia since 1896.



Bale & Danielsson, Ltd.

Map showing the increase in recent years of GLOSSINA MORSITANS in the Sebungwe District. Southern Rhodesia.

THE INFLUENCE OF TEMPERATURE, SUBMERSION AND BURIAL ON THE SURVIVAL OF EGGS AND LARVAE OF CIMEX LECTULARIUS.

By A. W. Bacot,

Entomologist to the Lister Institute.

These experiments were performed in response to a question submitted to me from the Royal Sanitary Institute. The point at issue was the possibility of eggs of the common bed-bug, *Cimex lectularius*, surviving the process of house-destruction, when the plaster from old walls, on which eggs had been laid, was broken down and remixed with fresh mortar for making the partitions of rooms in new tenements; such survival having been given as an explanation for previously unoccupied houses being infested with bugs.

Methods.

The ova used in the following tests were obtained by placing twenty to thirty adult specimens of *C. lectularius* in a 1½-inch glass-bottomed entomological box. The open top of the box was covered with fine gauze, through which the bugs were allowed to feed liberally each day. When feeding was not in progress the box containing the insects was kept in an incubator at 75°F. A slip of cloth was used as a lining to the box to afford foothold. As the great majority of the eggs were laid on the cloth this plan afforded an easy means of dividing up batches of eggs into two or more lots, so that controls could be obtained without any disturbance to the eggs. In order to get large numbers for some of the experiments the eggs were in certain instances allowed to accumulate for from three to five days before removal.

In experiments in which the eggs were submerged in water or buried in sand, those laid on cloth alone were used, but where the test was one of temperature alone, eggs laid on the sides of the boxes were occasionally utilised. In the case of the experiment with plaster the eggs were carefully detached from the sides of the box and cloth on which they had been laid. Control eggs were always taken from the same batch as those experimented with and all control eggs were kept from the time of laying in an incubator at 75°F.

The attached table shows the number of eggs in each batch, together with the date of laying. Batches are lettered from (*a*) to (*r*), and as the batch letter is quoted against each experiment, it is possible to follow the history and find the percentage hatching in different portions of the same batch which were subjected to different conditions.

Record of Eggs Laid and Nature of Experiments for which the various Batches were used.

Designation of Batch.	Number of Eggs in Batch.	Dates between which the various Batches were laid.	Numbers of Control Specimens.	Numbers of Specimens used in Experiments.		Submergence in			
				Cold.	Heat.	Water.	Wet Sand.	Dry Sand.	Lime Water.
a ..	90	15–21 Nov. '13 ..	—	45	45	—	—	—	—
b ..	75	21–23 ,, ..	—	37	38	—	—	—	—
c ..	61	23–27 ,, ..	25	—	—	11	25	—	—
d ..	87	27 Nov.–1 Dec. '13	29	—	—	—	—	58	—
e ..	45	1–4 Dec. '13 ..	15	—	—	30	—	—	—
f ..	93	4–9 ,, ..	15	28	50	—	—	—	—
g ..	33	9–15 ,, ..	13	20	—	—	—	—	—
h ..	18	24–25 March '13 ..	4	14	—	—	—	—	—
i ..	18	25–26 ,, ..	2	16	—	—	—	—	—
j ..	16	26–27 ,, ..	5	—	—	11	—	—	—
k ..	75	27–30 ,, ..	10	46	—	19	—	—	—
l ..	32	30–31 ,, ..	12	—	—	20	—	—	—
m ..	54	31 Mar.–2 Apr. '14	20	—	—	—	34	—	—
n ..	17	2–3 April '14 ..	6	—	—	11	—	—	—
o ..	70	3–6 ,, ..	11	41	—	18	—	—	—
p ..	25	6–7 ,, ..	8	—	—	17	—	—	—
q ..	73	7–10 ,, ..	13	60	—	—	—	—	—
r ..	50	1–6 May '14 ..	19	—	—	—	—	—	31

Temperature experiments.—Ova laid on cloth were enclosed in an entomological box (of card with a glass bottom), and this was nested in one of a larger size to avoid any possibility of escape. In cases where eggs laid on the sides of the card box were used, this box was enclosed in a larger one.

Submersion experiments.—Pieces of cloth on which the eggs were laid were fastened by one corner at the bottom of a waxed card jar and water was then poured in until the eggs were three or four inches below the surface.

Burial in sand.—A card jar was half filled with silver sand, the cloth with eggs attached was then placed on the surface and covered with sand to the depth of at least one inch. For the wet sand tests the jar was flooded with water, and the excess poured off. After the period of test the cloth was removed from the sand and placed in a box preparatory to hatching. As it was usually found that a few of the eggs became detached, the sand surrounding the cloth which contained the missing eggs, was placed in a second box. Washing off the surface on which they had been laid had no effect on the eggs, which hatched at the same time as those remaining attached to the cloth.

Plaster.—The plaster of Paris used in this experiment was mixed with lime-water. The surface was made very wet, so that the eggs might become partially embedded. They were scattered over the wet surface and became too firmly attached when the plaster set to allow of removal with a camel's hair brush.

Experiments with newly hatched bugs.—The insects used in these experiments were taken from among those hatching in the control boxes; they were not, therefore,

all from the same batch of eggs, but the eggs had all been subjected to similar conditions prior to hatching.

Ova subjected to cool conditions.

34 eggs of batch (*q*), kept between 40° and 55° F. (average temperature about 48° F.) for 12 days and then transferred to 75 °F.—32 hatched=94 per cent. (Control, 92 per cent. hatched.)

26 eggs of batch (*q*), kept between 40° and 55° F. (average temperature about 48° F.) for 20 days and then transferred to 75° F.—16 hatched=61 per cent. (Control, 92 per cent. hatched.)

46 eggs of batch (*k*), kept between 40° and 55° F. (average temperature about 48° F.) for 31 days and then transferred to 75° F.—25 hatched=54 per cent. (Control, 100 per cent. hatched.)

A marked feature of the last two experiments was the number of deaths during the act of emergence from the egg; in the last experiment no less than 10 (21 per cent.) failed to get free from the egg-shell.

Ova subjected to cold.

20 eggs of batch (*f*) kept at 28° F. for 6½ hours and then transferred to 75° F. —28 hatched = 100 per cent. (Control, 93 per cent. hatched.)

20 eggs of batch (*g*) kept between 28° and 32° F. for 24 hours and then transferred to 75° F.—19 hatched = 95 per cent. (Control, 84 per cent. hatched.)

14 eggs of batch (*h*) kept between 28° and 32° F. for 2 days and then transferred to 75° F.—13 hatched = 93 per cent. (Control, 100 per cent. hatched.)

16 eggs of batch (*i*) kept between 28° and 32° F. for 5 days and then transferred to 75° F.—4 hatched = 25 per cent. (Control, 100 per cent. hatched.)

41 eggs of batch (*o*) kept between 28° and 32° F. for 8 days and then transferred to 75° F.—10 hatched = 24 per cent. (Control, 100 per cent. hatched.)

45 eggs of batch (*a*) kept between 28° and 32° F. for 10 days and then transferred to 75° F.—*none hatched.* (Control, see batch (*a*) under Heat.)

8 eggs of batch (*b*) kept between 28° and 32° F. for 10 days and then transferred to 75° F.—*none hatched.* (Control, see batch (*b*) under Heat.)

29 eggs of batch (*b*) kept between 28° and 32° F. for 15 days and then transferred to 75° F.—*none hatched.*

Ova subjected to heat.

45 eggs of batch (*a*) kept at 98° F., humidity ·25 ;—41 hatched = 91 per cent.

38 eggs of batch (*b*) kept at 98° F., humidity ·25 ;—38 hatched = 100 per cent.

50 eggs of batch (*f*) kept at 113° F. ;—*none hatched.* (Control, 93 per cent. hatched.)

Ova submerged in water.

Between 60° *and* 63° *F.*

11 eggs of batch (*c*) submerged for 26 hours—11 hatched = 100 per cent. (Control, 96 per cent. hatched.)

30 eggs of batch (*e*) submerged for 44hours—23 hatched = 76 per cent. (Control, 93 per cent. hatched.)

18 eggs of batch (*o*) submerged for 3 days—17 hatched = 94 per cent. (Control, 100 per cent. hatched.)

19 eggs of batch (*k*) submerged for 3 days—19 hatched = 100 per cent. (Control, 100 per cent. hatched.)

11 eggs of batch (*j*) submerged for 5 days—10 hatched = 91 per cent. (Control, 100 per cent. hatched.)

Between 48° *and* 50° *F.*

20 eggs of batch (*l*) submerged for 24 hours—16 hatched = 80 per cent. (Control, 91 per cent. hatched.)

11 eggs of batch (*n*) submerged for 3 days—11 hatched = 100 per cent. (Control, 100 per cent. hatched.)

Between 28° *and* 32° *F.**

9 eggs of batch (*p*) submerged for 24 hours—9 hatched = 100 per cent. (Control, 100 per cent hatched.)

8 eggs of batch (*p*) submerged for 48 hours—7 hatched = 87 per cent. (Control, 100 per cent. hatched.)

Lime-Water.

50 eggs of batch (*r*) were submerged in lime-water (saturated solution of CaH_2O_2) for 46 hours at 63° F. and were then kept at 75° F. ;—*none hatched.* (Control, 100 per cent. hatched.)

Ova buried in sand.

Dry.

58 eggs of batch (*d*). The pot in which the eggs were buried was kept in a shed without doors, open towards the north from 1st to 5th December, 1913. Temperature about 43° to 47° F. The eggs were then transferred to the laboratory, at from 60° to 63° F.—58 hatched = 100 per cent. (Control, 76 per cent. hatched.)

Saturated.

25 eggs of batch (*c*). The pot in which the eggs were buried was kept in the same shed as mentioned above from 27th November to 1st December. Temperature about 43° to 50° F. The eggs were then transferred to the laboratory at 60° to 63° F. —24 hatched = 96 per cent. (Control, 96 per cent. hatched.)

20 eggs of batch (*m*). The pot in which the eggs were buried was kept in a cool room at from 47° to 53° F. for 4 days. The eggs were than transferred to an incubator at 75° F.—19 hatched = 95 per cent. (Control, 100 per cent hatched.)

14 eggs of batch (*m*). The pot in which the eggs were buried was kept in a cool room between 47° and 55° F. for one week. The eggs were then transferred to an incubator at 75° F.—12 hatched = 86 per cent. (Control, 100 per cent. hatched.)

Ova set in plaster.

25 eggs of batch (*s*) were carefully detached from the sides and bottom of the box and cloth on which they had been laid. The eggs were then scattered on to a very

*The water was frozen round the eggs.

wet plaster surface (gypsum, mixed with a saturated solution of CaH_2O_2) so that they were partially embedded. All were found to be attached. 13 hatched = 52 per cent.

Experiments with larval bugs in 1st instar.

Cold conditions; *unfed*. 7 unfed and 2 fed larvae were kept at between 28° and 32° F. for 2 days; they had then lost power of movement. After half an hour at 63° F. some had already recovered their activity. They were again kept at between 28° and 32° F. for 5 days and on examination were, to all appearances, dead, but after 4 hours at 63° F. they had all but one recovered their activity. After a further subjection to between 28° and 32° F. for 25 days they were kept at 63° F., but no recovery took place.

14 unfed larvae were kept at between 28° and 32° F. for 16 days and then kept at 63° F.; 3 made feeble movements after 2 hours, 6 were active after 24 hours, and 10 were active after 48 hours. The remaining 4 made no movement, but were probably paralysed rather than dead, as they showed no signs of shrinkage or decay after 96 hours, while their limbs reacted slightly to touch; 9 of the 10 that recovered were alive 12 days later.

Cold conditions; *fed*. 13 were allowed to feed on human blood and then kept in an entomological box at between 28° and 32° F. for 18 days. They were then transferred to 63° F. Only 3 showed any signs of life and one of these soon died; the remaining 2 lived for 15 days. Of these 13, it was very noticeable that all those which fed to excess failed to recover. Of the 3 which revived none had had a full meal, and the 2 which survived longest had obtained but little food. Death was not, I think, due to cold, but to the humidity in an artificially cooled room. Confinement in test-tubes, even when crumpled paper is given for a foothold, produces a high mortality among young, well-fed bugs, under ordinary laboratory conditions of temperature; while confinement in card boxes under similar conditions shows no death rate. Apparently it is necessary for bugs to be able to get rid of superfluous moisture rapidly after a heavy meal, and this is inhibited in a humid atmosphere.

Moderate conditions; *unfed*. 38 unfed larvae hatched at 60° to 63° F. from eggs that had been buried for 4 days in dry sand at between 43° and 47° F. (see experiment page 114, batch (*d*)) were kept in the laboratory at between 60° and 65° F., and afford an excellent example of the ability of this pest to survive unfed under favourable conditions.

23	were	active	after	66 days	10	were	active	after	117 days
20	,,	,,	,,	73 ,,	8	,,	"	,,	121 ,,
17	,,	,,	,,	85 ,,	7	,,	,,	,,	122 ,,
15	,,	,,	,,	89 ,,	6	,,	,,	,,	124 ,,
14	,,	,,	,,	93 ,,	5	,,	,,	,,	131 ,,
13	,,	,,	,,	106 ,,	4	,,	,,	,,	133 ,,
12	,,	,,	,,	110 ,,	3	,,	,,	,,	136 ,,
11	,,	,,	,,	112 ,,					

The experiment terminated during a heat wave, when the laboratory temperature was over 70° F.

Moderate conditions; after feeding. After a single meal one newly hatched bug out of three lived for 270 days; while, out of 30 immature bugs in various stages of development, 7 were living and able to feed after a fast of 18 months. In this case the box in which they were confined was kept in an outhouse.

Warm conditions; unfed. 20 unfed bugs kept in an incubator at 75° F., humidity between ·65 and ·70, show the following record:—

Average life	10 days
Longest life	21 days

16 unfed bugs, kept in an incubator at 88° F., humidity about ·70 to ·80 gave:—

Average life	7 days
Longest life	11 days

Of 32 unfed bugs kept at 96° F., humidity about ·25, the record was:—

Average life	5 days
One survived for	8 days

Hot conditions; unfed. 23 unfed bugs were placed in an incubator:

After $1\frac{1}{4}$ hours at 105.8° F. all were active.
,, $1\frac{1}{2}$,, ,, 109·4° F. ,, ,, ,,
,, 1 ,, ,, 111·2° F. ,, ,, ,,
,, 2 ,, ,, 113·0° F. ,, ,, dead.

4 unfed were placed in an incubator at 111·2° F.

After $\frac{1}{2}$ an hour all were active;
,, $1\frac{1}{2}$ hours ,, dead;
the temperature having risen to 112° F.

6 unfed were placed in an incubator at 113·0° F.

After $1\frac{3}{4}$ hours all were dead.

20 unfed were placed in an incubator at 113° F.

After 5 minutes all were active;
,, 10 ,, ,, ,,
,, 15 ,, ,, dead.

Blacklock* gives 5 minutes at 113° F. as the time required to kill larval bugs, but he does not state his method. It is possible that the use of card boxes with cloth-lined sides accounts for the longer survival of the insects experimented with in the present instance.

Summary.

Eggs.

Temperature. Eggs of *Cimex lectularius* are able to survive exposure to temperatures between 40° and 50° F. for periods of 31 days, and between 28° and 32° F. for 48 hours. Periods of from 5 to 8 days at the latter temperature reduce the percentage hatching to 25 per cent. and longer exposures—10 to 15 days—are fatal. Temperatures between 60° F. to 98° F. are favourable, but 113° F. prevents hatching.

*Annals of Tropical Medicine and Parasitology, iv, no. 4, Dec. 1912, pp. 415–428.

Burial in Sand. Burial in dry or wet sand, with exposure to temperatures between 45° and 50° F. may be survived from 4 days to a week if the eggs are then uncovered and kept at a favourable temperature.

Submersion in Water. Submergence in water at between 60° and 63° F. for a period of 5 days has no effect on hatching if the eggs are subsequently kept under favourable conditions. They also survive for at least 3 days in water at between 45° and 50°, and for 48 hours when the water in which they are submerged is frozen.

Lime-water. Submergence in lime-water (saturated solution) for 46 hours is fatal. The eggs survive partial embedding in a wet plaster surface provided that emergence is not interfered with.

Larvae.

Newly hatched bugs, when unfed, can survive a temperature of from 28° to 32° F. for periods up to 18 days. They are also able to withstand chilling, thawing, rechilling and again thawing over shorter periods. When subjected to cold, moist air after a full meal they are liable to a heavy or even total mortality—probably in consequence of humidity rather than cold.

Under moderate conditions of temperature—60° to 65° F.—they may live for 136 days unfed, and after a meal, for 9 months. Unfed, at a temperature of 75° F., with humidity between ·65 and ·70, an average life of 10 days, and an individual survival of up to 21 days is possible. At 88° F., with humidity between ·70 to ·80, the average life is shortened to 7 days—the longest survival being 11 days. At 96° F. with humidity at ·25 the average life is reduced to 5 days; individuals have survived for 8 days. Exposure to 113° F. is fatal within a few minutes.*

*This temperature also destroys adult fleas (*Xenopsylla cheopis*) in a few minutes; while two larvae of *Periplaneta americana* and a hibernated specimen of *Calliphora erythrocephala* survived the fleas at 113° F., but died within 15 or 20 minutes when the temperature had risen to 117° F.

PRELIMINARY LIST OF THE ACARI OCCURRING ON THE BROWN RAT (*MUS NORVEGICUS*) IN GREAT BRITAIN, WITH THE DESCRIPTION OF A NEW SPECIES (*HAEMOGAMASUS OUDEMANSI*).

By Stanley Hirst.

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Plates XIV–XVI.

The English specimens listed below were captured on wild examples of the brown rat by the author, and those from Scotland by Waterston. Several of these mites have already been recorded by Dr. A. C. Oudemans and other authors as occurring on this host. Only three of the species (*Laelaps echidninus*, *Notoedres muris* and *Myobia ensifera*) can be regarded with certainty as being practically restricted to *Mus norvegicus*, but this is possibly also the case with *Haemogamasus oudemansi*, which so far has only been found on this host. The other species are frequently found on other mammals or in their nests, especially in that of the mole (see Oudemans, Acarologisches aus Maulwurfsnestern, Arch. Naturg. Berlin, 1913).

My best thanks are due to Dr. A. C. Oudemans, of Arnhem, for the excellent drawings of *Haemogamasus oudemansi* which he has very kindly prepared and given to me. I must also thank Miss Gertrude Woodward for her careful drawings of the other species.

Family Gamasidae.

(1.) **Laelaps echidninus,** Berl. (text-figs. 1-3.)

Laelaps echidninus, Berlese, Acari, etc. Ital., fasc. xxxix, no. 1, figs. 1–4 (1887); Miller, Treas. Dept. Pub. Hlth. Mar. Hosp. Serv. Hyg. Lab., Bull. no. 46 (1908); Hirst, Bull. Ent. Res., iv, pp. 123 and 124, figs. 3 and 4 (1913).

Protonymph (fig. 1). Three pairs of fairly conspicuous little *shields* and also a pair of very minute platelets are present between the two main shields of the dorsal surface

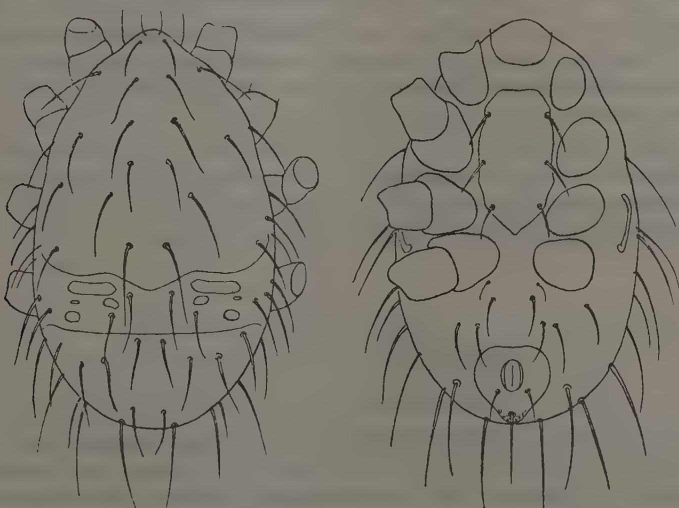


Fig. 1. Dorsal and ventral view of protonymph of *Laelaps echidninus*, Berl.

(for the shape and exact position of these shields, see fig. 1). The two large shields are marked with a reticulate sculpturing formed by numerous fine lines. *Sternal plate* reaching as far back as the interval between the third and fourth coxae, its posterior end being rather abruptly narrowed; three pairs of long fine hairs are present on this plate. *Peritreme* short, anteriorly it does not pass the third coxa. *Length* of body, ·65 mm.

Deutonymph (fig. 2). Dorsal surface covered with a single undivided shield which

Fig. 2. *Laelaps echidninus*, Berl., ventral view of deutonymph.

is marked by numerous fine lines, mostly running transversely across its surface. *Sternal plate* narrower and much longer than that of the protonymph, being prolonged posteriorly well beyond the fourth coxae; there are four pairs of long fine hairs on its surface. *Peritreme* extending almost as far forwards as the middle of the first coxa. *Length* of body, ·8 mm.

♂. *Chelicera* fairly long and styliform; at its base there is a delicate little lancet-shaped structure, and a membranous lobe, which perhaps functions as a sucker, is also present on the inner ventral surface of the basal end (fig. 3).

Fig. 3. *Laelaps ecnidninus*, Berl.; chelicera of male.

Loc. Several localities for this species are given in my paper quoted above. During July and August 1913, I found eleven more specimens on about three dozen wild rats (*Mus norvegicus*) captured at different times near Watford, Hertfordshire. The nymphs and male described above were bred (on white rats) from these specimens.

Laelaps echidninus is a true blood-sucking parasite. It is easy to demonstrate the presence of ingested blood of the host in the mite by teasing up freshly caught female specimens or making smear preparations of them, when large numbers of unaltered blood corpuscles will be seen.

Mr. A. Bacot, of the Lister Institute of Preventive Medicine, and myself have made a series of experiments with a view to ascertaining whether *L. echidninus* is capable of conveying plague from rat to rat or not. Unfortunately, we could not get good plague septicaemia in rats, and our experiments were therefore quite inconclusive. Mice develop good plague septicaemia, but *L. echidninus* will not bite mice readily, hence our experiments with *Mus musculus* also had to be abandoned. The mite could not be induced to bite human beings. It may be of interest to note that a bipolar staining bacillus very closely resembling the plague bacillus sometimes occurs in smear preparations of *L. echidninus* bred on apparently perfectly healthy rats.

(2.) **Eulaelaps stabularis,** C. L. Koch.

Loc. We have specimens of this species captured on *Mus norvegicus* at the following localities:—Northwood, Middlesex, 4. x. 1913; one specimen. Banks of River Thames, between Hampton and Kingston, 8. ix. 1913; thirty-five specimens. Clachan, Argyleshire, Scotland, 25. xi. 1909; one specimen (*Waterston*).

(3). **Hypoaspis hypudaei,** Oudms.

Loc. Northwood, Middlesex; a few specimens found on *Mus norvegicus*, x. 1913. Banks of River Thames, between Hampton and Kingston; thirty specimens found on *Mus norvegicus*.

(4.) **Haemogamasus hirsutus,** Berl.

Loc. Northwood, Middlesex; a single male specimen from *Mus norvegicus*.

(5.) **Haemogamasus nidi,** Mich. (Pl. XVI, fig. 8).

Haemogamasus nidi, Michael, Trans. Linn. Soc. Zool. (2) v, p. 314 & 315, pl. 32, figs. 6 & 7 (1892).

Haemogamasus michaeli, Oudemans, Tijdschr. Nederland. Dierk. Ver. (2) viii, pp. 87 & 88, pl. 6, figs. 33-39 (1904); Oudemans, Arch. Naturg. Berlin, Abt. A, heft 8, pp. 155-160, figs. 108-140 (1913).

♀. *Sternal plate* not much shorter in the middle than at the sides, but furnished with only three pairs of hairs, as in *H. oudemansi*. *Genito-ventral plate* somewhat enlarged and rounded posteriorly; the hairs on its surface are somewhat shorter and very much more numerous than is the case in *H. oudemansi*. *Anal plate* furnished with 7–9 hairs.

♂. *Chelicera*. Immovable finger rather gradually curved and the end pointed, but not abruptly turned down; it has a transparent lamina instead of a hair. Movable finger very strongly curved (claw-like) and sharply pointed. For the shape of its appendage see Pl. XVI, fig. 8.

Loc. Northwood, Middlesex; a large number of specimens taken at different times on *Mus norvegicus*, mostly in October 1913. Clachan, Argyleshire, Scotland; three specimens taken on *Mus norvegicus*, 25. xi. 1909 (*Waterston*). Lochgelly, Fife, Scotland; two specimens from *M. norvegicus*, 21. x. 1909. We have also a specimen

from *Mus sylvaticus*, taken on the banks of the River Thames between Hampton and Kingston. Also several specimens captured on *Talpa europea*, near Leipzig (*O. Fritsche*), presented to the Museum by the Hon. N. C. Rothschild.

In addition to the material mentioned above, I have examined Michael's types of this species and carefully compared them with some specimens from moles' nests, captured by Heselhaus at Sittard and determined by Oudemans as *H. michaeli*. I cannot find any difference between them. A tooth is shown on the immovable finger in Michael's figure of the chelicera of the male, but no such tooth is visible in his preparations of this appendage.

(6.) **Haemogamasus oudemansi,** sp. n. (Plates XIV—XVI).

♀. *Body* elongate oval and much enlarged posteriorly, usually it is much distended. The *scutum* leaves a considerable portion of the hinder part and sides of the body uncovered; for its shape see Pl. XV, fig. 4. Hairs both on dorsal and ventral surfaces long, fine and not nearly so numerous as is the case in the species of the genus hitherto described; at the anterior end of the scutum there is a pair of longer hairs, which are very finely feathered. *Sternal plate* very short in the middle, but well developed laterally; it bears three pairs of long fine hairs. *Genito-ventral plate* considerably widened and rounded posteriorly, the hairs on its surface being fairly numerous (never more than 22 ?) and long and fine. *Anal plate* pear-shaped, the narrowed posterior end being striate; it has only three hairs on its surface and they are long and fine (Pl. XV, fig. 6). *Peritreme* extending slightly beyond the coxa of the first leg. Immovable finger of *chelicera* with a rather well developed and sharply pointed tooth at a short distance from the distal end, the end itself being bifid; a very fine and rather short hair is present just before the end of this finger. Movable finger with two well developed teeth and its distal end is also turned up and tooth-like (Plate XV, fig. 1). Colour of *scutum* somewhat brownish yellow or buff, the soft integument whitish.

♂. *Chelicera*. Distal end of immovable finger distinctly turned down and pointed, and there is a very fine and rather short hair near the end. Movable finger bent abruptly distally so as to form a very large tooth; for the shape of the appendages of this finger see Pl. XVI, fig. 7.

Deutonymph. *Scutum* narrower than is the case in the female, and at rather more than a third of the length from the posterior end it has on each side a slight narrow incision, which is continued inwardly for a short distance by a slight linear groove or marking. *Sternal plate* rather long, narrowed posteriorly, and furnished with four pairs of hairs. *Anal plate* pyriform and not unlike that of the female.

Length of body of female, 1·1 mm.; of male, ·76 mm.; of deuteronymph, ·75 mm.

Loc. On the banks of the Colne Brook, near Watford, Hertfordshire; a few specimens were found on wild rats (*Mus norvegicus*) caught alive at this locality and forwarded to the British Museum. A number of specimens were bred on tame rats and mice at the Museum. Newton Abbot, Devonshire, v. 1914; a dozen specimens found in a kitchen used both as a living room and store room (*Dr. T. Cockburn Smith*).

In Panzer's "Deutschlands Insecten," Dr. C. L. Koch has figured a mite under the name *Gamasus marginellus* which has a dorsal shield shaped very like that of this

new *Haemogamasus*. This mite is depicted, however, as having a very wide body, whereas the body of *H. oudemansi* is always elongate and rather narrow, even when fully distended. Still it is possible that Koch's figure represents a specimen of the *Haemogamasus* described above as new, which has been greatly flattened under a cover glass. In his monograph of the genus *Gamasus*, Prof. Berlese states, however, that *G. marqinellus* is *G.* (*Pergamasus*) *crassipes*, L., or some allied species.

(7.) **Eugamasus loricatus,** Wankel.

Loc. Northwood, Middlesex; a single male deutonymph found on *Mus norvegicus.*

The shape of the epistome of my specimen is exactly the same as in a male deutonymph sent to the Museum by Oudemans, the central process being almost truncate (slightly rounded) at the end instead of pointed as is the case in the female deutonymph of this species.

(8.) **Euryparasitus terribilis,** Mich.

Loc. Northwood, Middlesex; a single deutonymph fo und on *Mus norvegicus.* In the British Museum Collection there are also some deutonymphs of this species from *Sorex vulgaris*, Nigg Bay, Kincardineshire, Scotland, 12. xii. 1910 (*L. G. Esson*); these specimens were presented to the Museum by the Hon. N. Charles Rothschild.

According to Oudemans *E. terribilis*, Mich., is a synonym of *Gamasus emarginatus*, C. L. Koch.

(9.) **Asca affinis,** Oudms.

Loc. I have examined specimens taken on *Mus norvegicus* at the following localities:—Northwood, Middlesex; one deutonymph. Kirkcaldy, Fife, Scotland, 8. xi. 1909; two deutonymphs (Waterston Coll.). Lochgelly, Fife, 21. x. 1909; one deuteronymph (Waterston Coll.).

Family Ixodidae.

(10.) **Ixodes tenuirostris,** Neum.

Loc. Northwood, Middlesex; a nymph and a female from *Mus norvegicus*, ix. 1913.

In the British Museum there are also specimens of this species found on *Evotomys glareolus* at Mumbles, Swansea (*C. Oldham*), and others taken on this host at Braunton, Devon (collected by *W. Holland* and presented to the Museum by the Hon. N. Charles Rothschild). Also a specimen from *Microtus agrestris*, from Cornwall, xii. 1913.

Family Sarcoptidae.

(11.) **Notoedres muris,** Megn.

Loc. Northwood, Middlesex; specimens taken from large excrescences on the ear of a wild rat (*Mus norvegicus*) in the autumn of 1913; also numerous examples from tame rats in London.

This species causes the sarcoptic mange of rats, a disease characterised by the presence of warty excrescences, often of large size, on the ears and in more advanced cases also smaller growths on the genitals, limbs and tail. This disease is very common amongst laboratory rats in London and, if neglected, affects the health of

these animals very seriously. A good account of the sarcoptic mange of rats is given by Dr. R. Cranston Low in his paper entitled "An Investigation into Scabies in Laboratory Animals" (Journ. Path. & Bact. XV, pp. 342–344, pls. XXXVIII & XXXIX, figs. 17–23, 1911).

Family TROMBIDIIDAE.

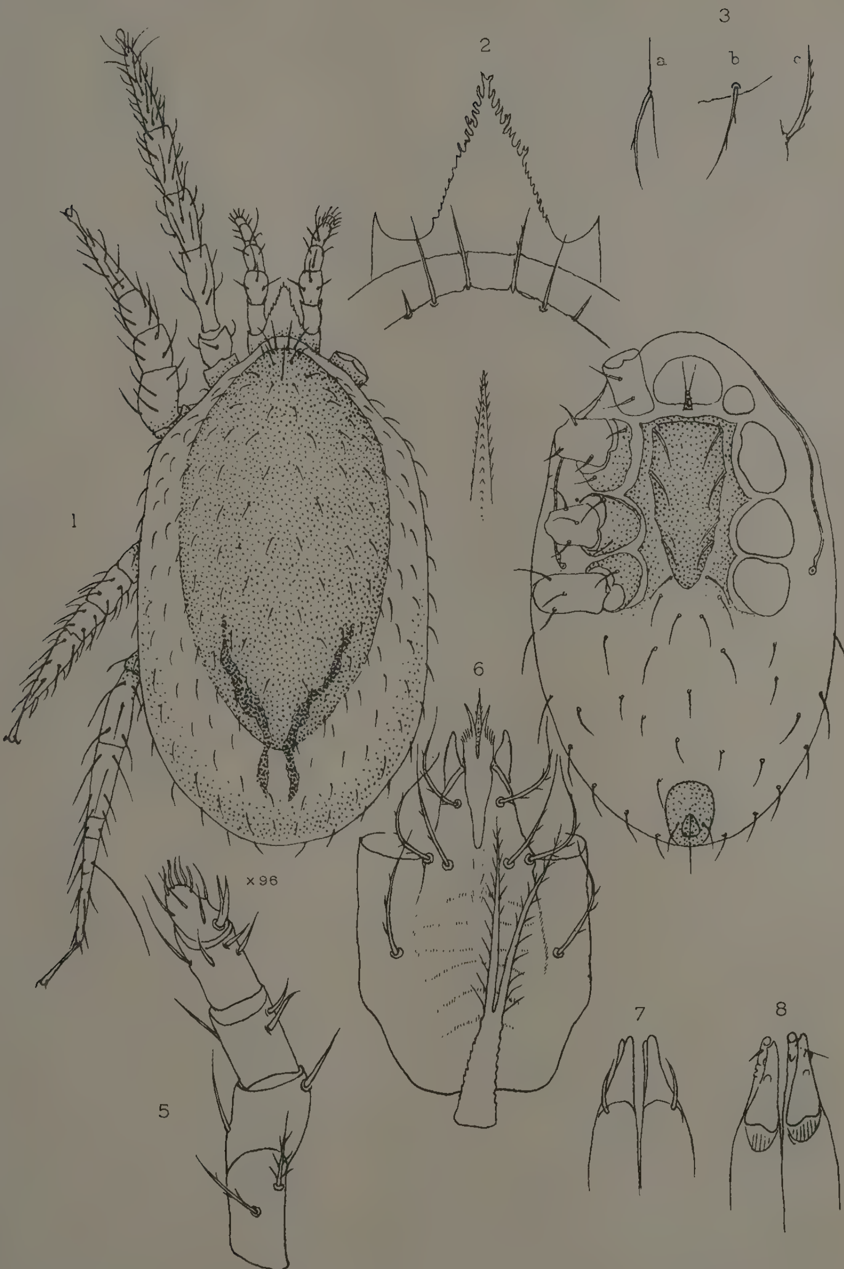
(12.) **Myobia ensifera,** Poppe.

Loc. Banks of River Colne, near Watford; specimens found on *Mus norvegicus*. This species is also very abundant on tame white rats in London.

EXPLANATION OF PLATE XIV.

Haemogamasus oudemansi, Hirst, deutonymph.

Fig. 1. Dorsal view of deutonymph, $\times 96$.
2. Epistome and anterior end of body, $\times 316$.
3. *a*, Side hair; *b*, posterior hair; *c*, hair on first femur.
4. Ventral view of deutonymph, $\times 96$.
5. The palp from below, $\times 316$.
6. Hypostome and tritosternum, $\times 316$.
7. Chelicera from above, $\times 316$.
8. Chelicera from below, $\times 316$.



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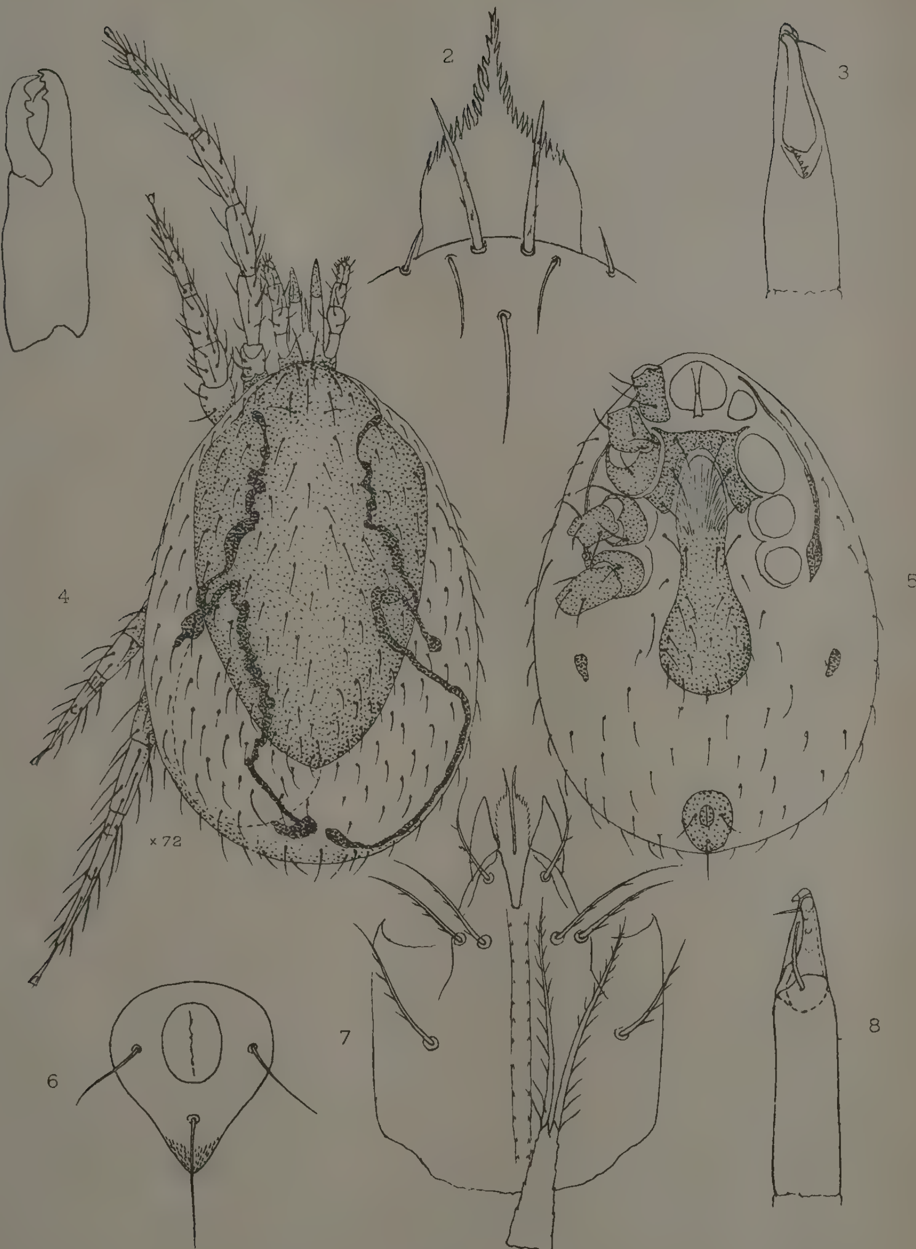
Haemogamasus oudemansi, Hirst, deuteronymph.

EXPLANATION OF PLATE XV.

Haemogamasus oudemansi, Hirst, female.

Fig. 1. Lateral view of chelicera, × 316.
2. Epistome and anterior end of body, × 316.
3. Ventral view of chelicera, × 316.
4. Dorsal view of female mite, × 72.
5. Ventral view of same, × 72.
6. Anal plate, greatly enlarged.
7. Hypostome and tritosternum, × 316.
8. Dorsal view of chelicera, × 316.



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Haemogamasus oudemansi, Hirst, ♀.

Explanation of Plate XVI.

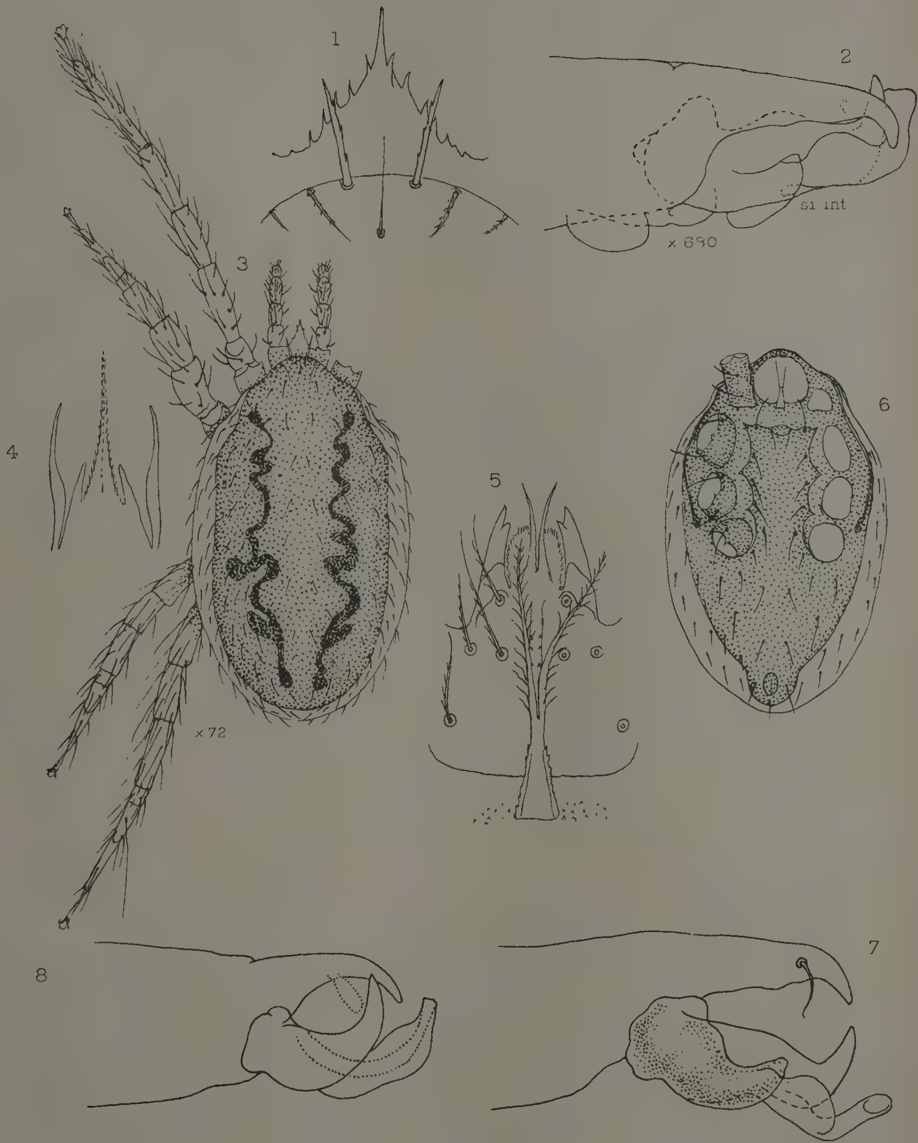
Haemogamasus oudemansus, Hirst, male.

Fig. 1. Epistome and anterior end of body, $\times 316$.
2. Lateral view of chelicera (fingers closed), $\times 680$.
3. Dorsal view of male mite, $\times 72$.
4. Inner structures of capitulum, $\times 316$.
5. Hypostome and tritosternum, $\times 316$.
6. Ventral view of body, $\times 72$.
7. Lateral view of chelicera (fingers open).

Haemogamasus nidi, Michael, male.

8. Lateral view of chelicera.

Note.—With the exception of figures 1 and 6 on Pl. XV and of figs. 7 and 8 on Pl. XVI, which were made by Miss Gertrude Woodward, the figures on these three plates were drawn by Dr. A. C. Oudemans, of Arnhem.



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FIGS. 1—7. *Haemogamasus oudemansi*, Hirst, ♂.
FIG. 8. *H. nidi*, Michael.

NEW CULICIDAE FROM BORNEO AND HONG KONG.

By F. W. Edwards.

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The following nine new species of Culicidae have recently been received by the Imperial Bureau of Entomology; the types have been presented to the British Museum.

Armigeres moultoni, sp. n.

♂♀. Scale structure and general appearance as in *A. obturbans*. *Head* scales black; a narrow rim of white round the eyes, and sometimes a few white scales on the nape. Palpi of male a little longer than, of female slightly more than one quarter as long as the proboscis. Basal joint of antennae with white scales; clypeus bare. *Thorax* with the scales of the mesonotum deep bronzy-black, no pale border, but the usual patches of white scales in front of the wing-bases and behind the prothoracic lobes. Scutellar scales all black. *Abdomen* deep black dorsally; the usual large lateral white patches; eighth segment white-scaled above. Venter white; broad black apical bands on segments 2–6, segments 7 and 8 entirely black. *Legs* black; narrow whitish lines on the under sides of the fore and mid femora; hind femora white, except for a dorsal black line, and the apical fifth, which is black on both the outer and under sides, as well as above and on the inside. Tibiae all about equal in length. Claws as in *A. obturbans*, except that the smaller claw of the front legs of the male is simple. *Wing* scales dark brown; the lateral scales on the first fork-cell somewhat broader than usual. Base of first fork-cell slightly nearer the apex of the wing than that of the second.

Male hypopygium: side-pieces pointed, the claspers inserted distinctly before the tip, claspers thickest in the middle, with four or five bristly spines towards the pointed apex. Basal lobes of side-pieces with four (or five ?) strong teeth.

Sarawak: Kuching, 19. ii—6. iii. 1914, 3♂ 10 ♀ (*J. C. Moulton*).

Malay States: Jugra, 15. ix. 1904, 1♀ (*Dr. G. F. Leicester*).

Differs from all previously described species in having the tip of the hind femora black on the outside, as well as in the very distinct male genitalia.

Armigeres brevitibia, sp. n.

♀. *Head* black above, with a small yellow spot in the middle and a yellow rim round the eyes; sides yellow with a large black spot. Clypeus bare. Basal joint of antennae with creamy-yellow scales. Palpi slightly more than one quarter as long as the proboscis, black. *Thorax* black above, sides broadly yellow, pleurae white-scaled. Postnotum bare. *Abdomen* black above, with the usual white lateral patches. Venter white, each segment with a large black triangle with its apex towards the base of the segment. *Legs* black; even the under sides of the fore and mid femora are black except at the extreme base; hind femora with the basal two-thirds white, the apical third black. Hind tibiae markedly shorter than either the front or middle ones, and about equal in length to the hind metatarsi. *Wings* as in *A. obturbans*.

Sarawak: Tabuan Swamp, Kuching, 25–26. ii. 1914, 1♀ (*J. C. Moulton*).

Distinguished from all known species except *A. moultoni* by the coloration of the hind femora, and from all except *A. (Leicesteria) flava* by the short hind tibiae.

Armigeres hybridus, sp. n.

Much resembles *A. obturbans*, but differs in the following particulars: The patch of whitish scales at the back of the head is smaller and often absent. The clypeus may or may not be scaly, but usually is not. Palpi of female about one-fifth as long as the proboscis. There is no distinct pale margin to the mesonotum, such as is always found in *A. obturbans*, though there are some whitish scales round the front of the thorax. The venter is entirely white, except for the seventh and eighth segments, which are black. The basal lobes of the side-pieces of the male genitalia bear three more or less elliptical plates with broadly rounded tips, and there are other slight differences in the male genitalia. The insect seems to be of a rather more slender build than *A. obturbans*.

Sarawak: Kuching, 14♂, 42♀ (*J. C. Moulton*).

Armigeres conjungens, sp. n.

♂ ♀. Closely resembles *A. hybridus*, but the male palpi are a trifle shorter, being scarcely longer than the proboscis. The male genital claspers instead of having a row of about 15–20 teeth, as in *A. obturbans* and *A. hybridus*, bear only four teeth in a row at the tip. The basal lobes of the side-pieces bear three sub-elliptical plates similar to those of *A. hybridus*. The whole hypopygium is much smaller than in *A. hybridus* or *A. obturbans*. The female (if correctly associated with the male) has the palpi almost one-third as long as the proboscis.

Sarawak: Kuching, 25. ii—5. iii. 1914, 3♂ (including type) 2♀ (*J. C. Moulton*).

There is a single male in Dr. Leicester's collection in the British Museum, unlabelled, but probably from the Malay States.

This species connects *Armigeres* with *Leicesteria*, having the coloration of *Armigeres*, the genitalia of *Leicesteria* and the female palpi intermediate between the two groups. It seems advisable in view of the discovery of *A. conjungens* and of *L. omissa* (which approaches *Armigeres* in the structure of its genitalia) to unite the two groups into one genus. The larvae of the two groups differ only in minor specific characters.

Culex virgatipes, sp. n.

♂ ♀. *Head* with reddish-brown narrow curved scales. Proboscis black above, yellowish below; in the male the pale scales of the under surface spread upwards in the middle, giving a suggestion of a pale band. Male palpi longer than the proboscis by rather more than the length of their terminal joint; the basal joint has the usual narrow pale ring before the middle and has also a patch of ochraceous scales on the outer side towards the apex; the two terminal joints have a white-scaled line beneath. *Thorax* reddish brown, clothed with reddish-brown scales, except on and in front of the scutellum where the scales are pale yellowish. *Abdomen* dark brown, with ochraceous basal bands on each segment, which are somewhat broader in the middle in the female; the one on the seventh segment spreads out laterally and reaches the apex of the segment on each side. Venter ochraceous. Male genitalia identical in structure with those of the African *C. trifilatus*, Edw. *Legs*: front and middle femora and tibiae blackish in front, ochraceous behind; the front and middle femora and the middle tibiae also with a well-marked ochraceous longitudinal stripe in front; hind femora ochraceous, with a dark dorsal line; hind tibiae dark with an ochraceous longitudinal stripe and a distinct ochraceous spot at the tip;

knee-spots distinct; tarsi blackish, with an ochraceous line beneath, at least on the basal joints. *Wings* clothed with brown scales, the lateral vein-scales linear; fork-cells long, the upper one with its base much nearer the base of the wing than that of the lower. Cross-veins separated by fully the length of the posterior.

HONG KONG: 82♂ and ♀ (including type ♂) (*Dr. H. Macfarlane*). KASHMIR: Gulmarg, summer 1913, 4♂ 7♀ (*Lt.-Col. F. W. Thomson*).

This is a remarkably interesting species, possessing as it does the thorax and wings of *C. pipiens*, leg markings of *C. tipuliformis*, and the genitalia of *C. trifilatus*.

Lophoceratomyia curtipalpis, sp. n.

♂. *Head* dark brown; flat white scales at the sides extending upwards as a narrow margin round the eyes. Palpi only half the length of the proboscis, straight, without hair-tufts. *Antennae*: basal joint large, with a frosted appearance; a large projection on the inner side bearing some short pubescence. Joints 2–6, as usual, very short and somewhat swollen; 6th joint with a few very long, almost hair-like, dark brown scales on its under side; 7th joint with a few short hair-like crumpled scales on its under side; 8th and 9th joints with the usual tufts of scales projecting somewhat inwards, that on the ninth segment being the longer; 10th joint without scales. *Thorax* dark brown; dark brown scales on the mesonotum and scutellum and some flat white ones on the pleurae. *Abdomen* dark brown above, sides and venter whitish. *Legs* dark brown; under sides of femora whitish; the larger and perhaps also the smaller claws on the front and middle legs each with a single tooth. *Wings* brown-scaled; the upper fork-cell nearly twice as long as its stem and with its base much nearer the base of the wing than that of the lower.

SARAWAK: Kuching Reservoir, 6. iii. 1914, 5♂ (*J. C. Moulton*).

This species has a general resemblance to *L. uniformis*, the antennal structure being very similar, but the unusually short palpi are possessed by no other member of the genus. *L. brevipalpus* and *L. hewitti* have the palpi somewhat short, but still not much shorter than the proboscis.

Uranotaenia macfarlanei, sp. n.

♀. *Head* clothed with black scales, with a rim of white ones round the eyes. Proboscis black-scaled, slightly longer than the abdomen. *Thorax* dark brown, rather thickly clothed with dark brown bristles and light ochraceous-brown scales; a line of white scales in front of the wings extending forwards as far as the front of the mesonotum, the first half of this line composed of flat scales, the second half of narrow ones; another line of flat white scales crosses the pleurae and the prothoracic lobes. *Abdomen* black dorsally, with large white apical bands on segments 1–6; first segment with a small white apical lateral spot connected with the band, segments 2–4 with small snow-white apical lateral spots not connected with the bands; segment 5 with a large snow-white apical lateral patch connected with the band. *Legs* blackish; under sides of femora and tips of femora and of hind tibiae whitish. *Wings* brown-scaled, the base of the first longitudinal vein white-scaled; the lateral vein-scales ovate.

HONG KONG: 3♀ (*Dr. H. Macfarlane*).

This species differs from *U. argyrotarsis*, Leic., and *U. albescens*, Taylor, in its entirely dark hind tarsi, and from the African *U. alboabdominalis*, Theo., in the colour of its head scales as well as in some other particulars.

Uranotaenia moultoni, sp. n.

♂♀. *Head*, including proboscis, palpi and antennae, black. Proboscis scarcely as long as the abdomen. *Thorax* bright orange, with black bristles and small narrow black scales on the mesonotum. Prothoracic lobes and pleurae unscaled. Scutellum with small flat black scales. No line of flat scales in front of the wings. *Abdomen* clothed entirely with blackish brown scales above, without spots or bands. *Legs* entirely black-scaled, normal in structure. *Wings* brown-scaled; lateral vein-scales ovate; venation normal.

SARAWAK: Kuching Reservoir, 6. iii. 1914, 2 ♂ 1 ♀ (*J. C. Moulton*).

U. moultoni belongs to a group of closely allied forms which includes *U. nigripes*, Theo., *U. lutescens*, Leic., and *U. bicolor*, Leic. It differs from all these in its entirely unbanded abdomen.

Rachionotomyia vicina, sp. n.

Head with a broad band of flat scales in front which are brilliant blue or dull grey according as they are viewed from in front or from behind. Clypeus orange to dark-brown. Basal joint of antennae orange, more or less darkened on the inside. Palpi and proboscis black, the former 2–2½ times as long as the clypeus. *Thorax*: prothoracic lobes and the area of the mesonotum just behind them clothed with flat black scales. Integument of mesonotum shining blackish brown, except round the front margin, where it is orange, rather sparsely clothed with very narrow straight submetallic greenish scales; scutellum with flat black scales. Pleurae orange, with a large blackish-brown patch which is densely clothed with flat silvery scales. *Abdomen* black-scaled dorsally, segments 2–7 with large silvery lateral patches situated towards the apices of the segments; venter golden. Male genitalia very similar to those of *R. coeruleocephala* (Leic.), but the "setaceous lobes" are larger. *Legs*: coxae and trochanters orange; femora black, hardly paler beneath, each with two silvery-white spots on the apical half in front; the middle femora also have a silvery white line at the base in front; tibia and tarsi black. In the male the claws of the front legs are very unequal, the larger one with a distinct tooth; those of the middle legs rather small, and nearly equal, those of the hind legs simple and equal. *Wings* with small brown scales, the lateral ones narrow. Base of the upper fork-cell a little nearer the apex of the wing than that of the lower.

SARAWAK: Kuching Reservoir, 6. iii. 1914. 30 ♂ 5 ♀ (*J. C. Moulton*).

This species rather closely resembles *R. coeruleocephala* (Leic.), *R. nitidiventer* (Giles) and *R. powelli* (Ludlow), differing from the first in the dark colour of the integument of the mesonotum and in the greenish scales with which the mesonotum is clothed, as well as in the claws and the male genitalia; from the second, in the blackish, instead of blue, scales on the prothoracic lobes; and from the third in the greenish instead of dark brown scales of the mesonotum. *R. nitidiventer*, *R. powelli* and *R. vicina* might well be regarded as forms of one species, but as I could see no variation in the Borneo specimens and as the males of *R. nitidiventer* and *R. powelli* are not known, I have provisionally accorded *R. vicina* specific rank.

THE ANOPHELES OF MALAYA.—Part II.

By A. T. Stanton,

Institute for Medical Research, Kuala Lumpur, Federated Malay States.

Anopheles kochi, Dönitz.

Anopheles kochii, Dönitz, Insecten-Börse, xviii, p. 1 (1901).

Cellia kochii, Dönitz, Theobald, Mono. Culic., iii, p. 110 (1903).

Cellia flava, Ludlow, Can. Ent. xl, p. 32 (1908).

Christophersia halli, James, Paludism, i, p. 32 (1910).

This species was first described by Dönitz from specimens taken in Sumatra. About the same time Theobald had prepared from Malayan specimens the description of an Anopheline species for which he proposed the name *ocellatus*, but recognising that Dönitz' *kochii* and his own *ocellatus* were the same species he published his description as that of *Anopheles kochii*, Dönitz.

Some years later, Major James, I.M.S., examined a specimen from the Indian Museum, Calcutta, labelled "*Cellia kochii*," but which he recognised as differing from other species in the genus *Cellia* in the position of the tufts of abdominal scales. Mr. Theobald to whom the specimen was sent for examination was of opinion that it represented a new Anopheline genus; it was accordingly described by James under the name *Christophersia halli*. The peculiar character of the scale-tufts in *kochi* had already been noted by Dönitz, who, referring to the abdominal scale-tufts in the species *pharoensis* and *squamosus*, wrote (Zeit. für Hygiene, xli, 1902) "Diese Büschel sind aber doch etwas ganz anderes als die Schuppenbüschel bei *An. kochi* die an der Bauchseite in der Mittellinie liegen."

Comparison of Malayan specimens of *kochi* with Indian specimens of *halli* showed that they were the same species and the latter was included by James and myself in our list of Malayan species (Trans. Far East Assn. Trop. Med. 2nd Cong., 1912, p. 317). Examination of specimens at the British Museum showed, however, that *halli*, James, was identical with *kochi*, Dönitz, which is the correct name for this Malayan species. In James' system of classification it is named *Christophersia kochi* (Christophers, Ann. Trop. Med. Parasit, vii, p. 60, 1913).

The mosquito described under the name *Cellia flava* by Miss Ludlow from specimens taken in the Philippine Islands is also no other than *kochi*, Dönitz, as has recently been shown by Edwards (Bull. Ent. Res., iv, p. 22, 1913).

The description and illustration of "*Christophersia halli*" given by Strickland in his "Short Key to the Identification of the Anopheline Mosquitoes of Malaya" are incorrect for this species. The number of abdominal scale-tufts does not exceed six and they are found on the second to seventh segments only.

The following descriptions are based on the study of the ova laid by a female in captivity and of the larvae, pupae and imagines which developed therefrom. Twenty days elapsed from the deposition of the ova to the emerging of the imagines.

The Ovum.

The upper surface is narrow, slightly expanded at either end, and the floats do not touch its margin. The narrow striated frill is continuous around the whole of the margin of the upper surface. The thin silvery membrane which covers the under

surface of the ovum and the lateral areas between the floats and the frill, has a reticulated pattern. The floats are oblong in shape and extend over the middle two-thirds of the ovum's length; each float has about twenty corrugations. Length of ovum 0·45 mm., greatest breadth 0·16 m.m.

This ovum does not differ in any detail from that of *A. tessellatus* (Bull. Ent. Res. iv, p. 131).

The Newly Hatched Larva.

When it emerges from the egg the larva of *Anopheles kochi* is peculiar among the Malayan species so far examined in regard to the form of the anterior clypeal hairs. Even those species in which these hairs are much branched in the mature form show only simple bristles in the earliest stage of the larva; in *kochi*, however, the inner pair of anterior clypeal hairs are coarsely pinnate in the newly hatched larva, though they are only very finely so in the mature form.

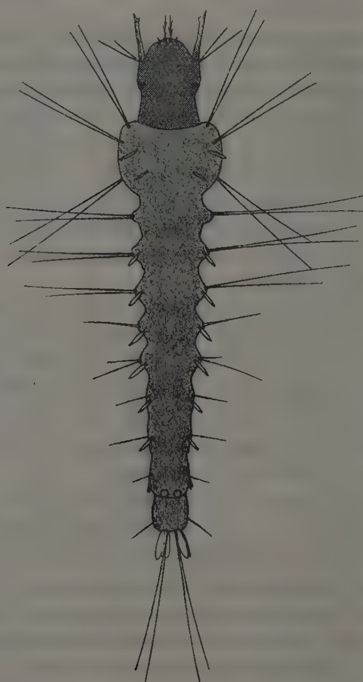


Fig. 1. Larva of *Anopheles kochi*, Dön., after first moult.

Fig. 1 shows the appearance of the larva after the first moult. At this stage it differs from the newly hatched larva only in its greater length and in the elongation of the head. The form and arrangement of the hairs remain as in the newly hatched larva and are as follows:—

Head. The inner anterior clypeal hairs are long and coarsely pinnate. The outer anterior clypeal hairs are short, only about one-fourth the length of the inner, and

simple. The posterior clypeal hairs are placed far back, widely separated from one another, and simple.

Thorax. On the dorsum of the thorax are borne four pairs of simple leaflets, two pairs on the anterior edge of the thorax and two pairs in the position shown in the figure.

Abdomen. A pair of simple leaflets is borne on each segment of the abdomen from the second to the seventh.

The Mature Larva (fig. 2).

Head. The inner anterior clypeal hairs are long and widely separated from one another; these hairs are very finely pinnate, a character that can however be discerned only with high magnifications. The outer anterior clypeal hairs are very short and are placed close to the inner; they are about one-fourth the length of the inner, and simple. The posterior clypeal hairs are placed far back and slightly external to the line of the inner anterior clypeal hairs; they are about equal in length to the outer anterior clypeal hairs and are simple. The position of the posterior clypeal hairs is a character which enables one readily to distinguish the larva of *kochi* from the larva of *rossi* and other species which in some characters it resembles. Of the two pairs of hairs placed behind the row of six frontal hairs and between the eyes the inner are simple and the outer branched.

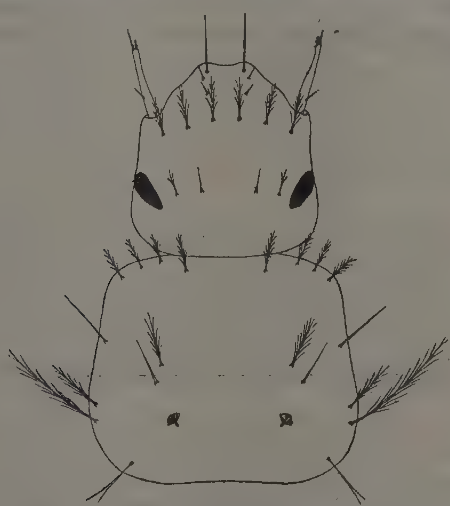


Fig. 2. Head and thorax of mature larva of *Anopheles kochi*, Dön.

Thorax. In addition to the usual stout feathered hairs and bristles, the dorsum of the thorax carries a pair of palmate hairs; each whorl is composed of ten leaflets which are long and narrowly lanceolate in form.

Abdomen. Palmate hairs are borne on the second to seventh segments. On the first two and the last of these segments, the leaflets are narrowly lanceolate, on the

middle segments they are broad and end in a short blunt-pointed filament. The spiracle comb carries fourteen spine-like processes on each side, four of which are of larger size than the others ; the basal parts of these processes carry minute teeth.

The Pupa.

The first abdominal segment bears the usual pair of fan-like tufts of branched hairs. Small lateral spines are present on the fourth to seventh abdominal segments ; on the fourth segment these spines are minute.

The mature larva of *kochi* so closely resembles that of another Malayan species, *tessellatus*, that there is no easily recognisable character by which they may be distinguished. The presence of a pair of palmate hairs on the second abdominal segment in *kochi* and the absence of this structure in *tessellatus* appears to be constant. There is no very close resemblance between the imagines of these species, apart from certain markings, such as the lighter colour of the apical half of the proboscis in the females of both.

From this and similar observations in other species, it appears that the most that is likely to be gained of practical advantage in malaria prevention from a study of larval forms in *Anopheles* is a separation into groups that may comprise two or more species. These studies do promise however to give us a clearer knowledge of the natural affinities of species than has been gained from a study of the morphology of the adult insects.

I am indebted to Mr. R. W. Blair for the accompanying drawings.

PRELIMINARY NOTES ON EGYPTIAN MOSQUITOS.

By Dr. L. H. Gough,

Entomologist, Ministry of Agriculture, Egypt.

The mosquito fauna of Egypt appears to have received very little attention hitherto, and very few species have been recorded from this country up to the present.

The following list of species is based chiefly on the collection of the Ministry of Agriculture, and is supplemented by references to species recorded by other observers but not taken by us. The synonymy used is that proposed by Mr. F. W. Edwards in his papers :—"The African Species of Culex and allied Genera" (Bull. Ent. Res., ii, p. 241, 1911); "Further Notes on African Culicidae" (Bull. Ent. Res., iv, p. 47, 1913); "Key for determining the African Species of *Anopheles*" (Bull. Ent. Res., iii, p. 241, 1912), excepting where the contrary is stated.

1. **Anopheles pharoensis** (Theobald).

Localities: Cairo, Meadi, Damietta, Shebin El Kom, Khanka, Abon Roasa, Meherique (Kharga Oasis).

Breeds in fresh water, in stagnant ponds and similar places (Birkas); fairly common. Was found associated with an outbreak of malaria at Meadi.

2. **Anopheles squamosus** (Theobald).

Localities: Recorded from Kafr El Dawar by Theobald (Monograph, iv, p. 110) from specimens taken by Mr. F. C. Willcocks; not seen since.

3. **Anopheles turkhudi,** Liston.

Anopheles multicolor, Camboulin, C.R. Acad. Sci. Paris, cxxv, p. 704 (1902).
Anopheles impunctus, Dönitz, Zeitschr. f. Hygiene, xli, p. 67, pl. ii, fig. 15 (1902).
Pyretophorus chaudoyei, Theobald, Monogr. iii, p. 68 (1903).
Pyretophorus nigrifasciatus, Theobald, Monogr. iv, p. 65 (1907).
Pyretophorus myzomyfacies, Theobald, Monogr. iv, p. 69 (1907).
Myzomyia azriki, Patton, Journ. Bombay Nat. Hist. Soc. xvi, p. 632.
Myzomyia hispaniola, Theobald, Monogr. iii, p. 49 (1903).
Pyretophorus cleopatra, Willcocks (*nomen nudum*), Ann. Trop. Med. Parasit. iii, p. 586.

Comparison of a series of over 200 specimens forces me to the conclusion that all the above names must be sunk as synonyms of *Anopheles multicolor*, Camboulin, which is a most variable species in regard to its wing markings. *A. impunctus*, *A. multicolor* and *A. chaudoyei* are said to differ from each other in the amount of black on various veins; *A. impunctus* being the species with the least and *A. multicolor* with the greatest extent of black markings on its wings. These characters are, however, unreliable, for my specimens not only grade quite imperceptably from examples with hardly any black on their wings (*A. impunctus*), to intermediate (*A. chaudoyei*), and to very dark-winged insects (*A. multicolor*); but also one finds single specimens in which the two wings are different, the characters of *A. impunctus* and *A. chaudoyei*, or *A. multicolor* and *A. chaudoyei* being combined in one individual. The proportionate sizes of the costal spots also vary to some extent.

The resemblance of this species to the published description of *A. hispaniola* is remarkable, the only difference apparently being in the vestiture of the thorax and scutellum. Some specimens of *A. multicolor* show part of the thorax covered with hairs, especially at the sides above the wings; in others the thorax is above entirely covered by scales. I have not seen indubitable specimens of *A. hispaniola*, but seeing that Edwards (Bull. Ent. Res. iii, p. 249) places *Pyretophorus myzomyfacies* as a synonym of *Myzomyia hispaniola*, the difference of the vestiture of the thorax, which is the generic difference between *Myzomyia* and *Pyretophorus*, can no longer be valid. Colonel Alcock (Synopsis of Anopheline Mosquitoes, Journ. London School Trop. Med. ii, p. 161), quoting James and Liston, suggests that *A. chaudoyei* may also be found to be synonomous with *A. turkhudi*, with which opinion I agree, as there appears to be no difference in the descriptions which can be considered of specific value, seeing the great variation in our series.

Myzomyia azriki, Patton, only differs from *A. multicolor* in the entirely dark-fringed wings. This again is not a constant character, my specimens varying from having distinctly yellow-spotted fringes to having uniform dark fringes.

In Egypt, *Anopheles turkhudi* normally breeds in brackish water; I have reared it from water containing 2 per cent. of salt. At Helouan it breeds freely in a small brook of highly saline water; its larvae are however also found in stagnant collections of brackish water. This species is possibly a malaria-carrier, being the only *Anopheles* that we have received in numbers from Kharga Oasis, where malaria is very prevalent and where the insect is very abundant.

The revised synonomy shows that the species has a continuous range from Teneriffe and Spain, through Algiers, Egypt, Arabia, Cyprus, Baluchistan to India,

Localities: Wadi Natroun (Dönitz), Cairo, Meadi, Helouan, Suez, Kharga Oasis, Baharia Oasis.

4. **Anopheles culicifacies**, Giles.

Pyretophorus sergenti, Theobald.

Pyretophorus palestinensis, Theobald.*

This species is now known to range continuously from Algeria, through Egypt, Cyprus and Palestine to India and Ceylon.

Localities: Helouan (brackish water), Baharia Oasis, Siwa Oasis, Kharga Oasis. Rather rare.

5. **Anopheles mauritianus,** Grandpré.

Localities: Alexandria, Damietta. Not rare in the North of the Delta.

6. **Stegomyia fasciata,** Fabricius.

Localities: Port Said, Cairo, Meadi, Fayoum, Suez. Not rare.

One specimen of the variety *queenslandensis*, Theo., has been taken at Suez.

7. **Stegomyia sugens,** Wiedemann.

Locality: Nubia (Wiedemann). Possibly this species is not Egyptian, as the original record (1828) may have referred to what is now known as the Sudan.

* [After examining the type of *P. palestinensis*, Mr. F. W. Edwards states that it is certainly not synonymous with *A. culicifacies*, but is nearly allied to *A. turkhudi*, and and perhaps a variety of it.—Ed.]

8. **Ochlerotatus longisquamosus** (Theobald).
Locality: Siwa Oasis, one specimen only.

9. **Ochlerotatus aegypti** (Linné).
Culex dorsalis, Meigen.
Grabhamia dorsalis, Theobald, Monogr. iii, p. 251 (1903).
Grabhamia subtilis, Ed. & Et. Sergent, Bull. Mus. Paris, xi, p. 240 (1905).
Grabhamia willcocksii, Theobald.
Ochlerotatus dorsalis, Edwards, Bull. Ent. Res. ii, p. 248 (1911).

This is one of the commonest Culicine mosquitos in our collection, and as Linné's description of *Culex aegypti* fits it very well, there can remain very little doubt that it is really the same species, especially as there appears to be no other common Egyptian species fitting the description. It breeds in brackish as well as fresh water.

Localities: Cairo, Meadi, Gizeh, Helouan, Baharia Oasis, Siwa Oasis, Kharga Oasis.

10. **Theobaldia spathipalpis** (Rondani).
Localities: Cairo, Meadi, Imbaba, Kharga Oasis; chiefly in winter.

11. **Culex quasigelidus,** Theobald.
Locality: Meadi; rare.

12. **Culex** (?) **invidiosus,** Theobald.

I have provisionally identified a small *Culex* under this name, but the specimens appear to me to fit the description of *Culex guiarti*, Theobald, equally well. The apical dark banding of the venter of the abdomen, or its absence, used by Edwards in his key, is not a constant character, the banding is quite distinct in some of my specimens and absent in others. It breeds in fresh water, and is quite common.

Localities: Meadi, Cairo, Dessuk, Port Said, Shebin El Kom, Damietta.

13. **Culex theileri,** Theobald.
Locality: Kharga Oasis; rare.

14. **Culex pallidocephalus,** Theobald.
Localities: Meadi, Fayoum, Shebin El Kom, Siwa Oasis; common.

15. **Culex quasimodestus,** Theobald.
Localities: Meadi, Fayoum, Bahria Oasis; not common.

16. **Culex fatigans,** Weidemann.
Localities: Cairo, Giza, Meadi; common.

17. **Culex pipiens,** Linné.
Localities: Cairo, Meadi, Giza, Aswan, Baharia Oasis.

This is the commonest Culicine mosquito near Cairo.

My thanks are due to Mr. J. Bitter and Capt. Thomson of the Public Health Department for having collected very many of the mosquitos recorded here, including all the specimens taken in the Oases, and most of those collected elsewhere than at Cairo, Meadi, Giza, Helouan and the Fayoum.

AN ACCOUNT OF SOME ANOPHELINE MOSQUITOS FOUND IN BRITISH NORTH BORNEO, WITH DESCRIPTION OF A NEW SPECIES.

By Richard Roper, F.R.C.S. (Edin.).

(Maps III and IV).

During the course of three years' estate medical work in British North Borneo, ample opportunity was found for studying the local mosquitos, and I publish the few following notes in the hope that they may be of use to other workers in Borneo.

The area of country covered was about 45 miles along the west coast of the Chartered Company's territory between Jesselton and Membakut, roughly between degrees 115° and 116° E. Long., and 5° and 6° N. Lat. The distance from the coast, here known as Kimanis Bay, varied between six and nine miles.

The climate of this part of Borneo is fairly even, and records of temperature taken inside one of the hospitals during the two years 1912–1913 showed it to vary between 74° F. and 84° F. The average yearly rainfall worked out at 94 inches for the past seven years. There is no very prolonged season of wet weather, but the rainfall seems to be distributed evenly throughout the year. A good deal of this part of the coast is swampy with here and there areas of high land, rising in places to hills 50 to 200 feet high. Many of these hills have small streams coursing down them. The jungle for the most part is light and in places has been felled for cultivation of hill rice. Much of this jungle has also been felled by rubber companies in the last five years. The flat land along the 45 miles mentioned is used by natives in places for cultivation of rice and, in a very promiscuous way, sago.

The whole population of this part of Borneo is small and they have suffered much from epidemics of smallpox and cholera. Of the native races those known as Dusuns are the most populous, especially near Papar. In the neighbourhood of any railway station or settlement of Europeans the local population is generally Chinese. The labour on the estates consists mostly of indentured Chinese and Javanese, with a few natives as free labour.

Four rivers enter the sea along this piece of coast, namely, the Papar, Kimanis, Bangawan and Membakut, none of which is of any size, and they are only navigable for quite small craft.

A few isolated mosquitos have been taken from estates along the coast, but by far the majority have been captured or bred from larvae in the neighbourhood of Membakut.

The Membakut village is situated (*see* Map III) practically at the spot where the railway crosses the Membakut river. It stands nearly in the centre of a large area of swamp land extending about six miles north, twelve miles south and six miles west towards the coast. Along this coast there are two types of swamp land, one with large and deep pools, the other with small shallow pools. The latter is the variety met with near Membakut and especially so near the railway along the western side.

A few hundred yards south of Membakut village, close to the railway and on the eastern side of it, are the buildings of Rubber Estate (A), in which many adult Anophe-

lines have been taken. The species that have been found in the houses have in many cases been bred also from larvae taken in the swamp. As can be understood, there was much malaria among the coolies on the estate in spite of prophylactic quinine being taken, their spleen rate being 21·4 per cent.

For an area of about ten miles around Membakut six villages or collections of houses were visited with a view to ascertaining the spleen rate of the children. The ordinary native hut is generally of bamboo on piles 3 to 6 feet high and is dotted anywhere in the neighbourhood of land likely to serve as paddy land, without regard to proximity of swamp or jungle. Among this particular group of villages there was one larger than the rest, known as Kampong Brunei, situated on the banks of the Membakut river, and here in 39 children the spleen rate was found to be 58·9 per cent. In this part of Borneo all the larger villages have been built on the rivers and the natives get their living by fishing and a small amount of rice-growing, the latter almost entirely for their own consumption. The other five villages were practically situated in the large swamp already mentioned and consisted of groups of houses rather widely separated. Sago palm grows everywhere in the neighbourhood and also some of the smaller fruit trees and a few coconut trees. Including Kampong Brunei, I was able to examine 92 children and the spleen rate of this number worked out at 54·3 per cent.

The following table shows the name of the village and the number of children examined in each, with the spleen rate :

Village.	No. of children examined.	Spleen rate.
Membakut, with surrounding villages	92	54·3
Bangawan	69	1·42
Kimanis	52	11·53
Papar (Mill Hill Mission)	37	13·5

As a rule, in a village situated on the banks of one of these rivers the health of the natives as regards malaria is good, as will be seen in the case of Kimanis and Bangawan villages. In the case of Kampong Brunei the high spleen rate seems to be connected with the proximity of this extensive swamp, which is only about one mile distant.

During the examination of these children one was naturally led to examine them for evidence of other diseases than malaria, but except for one child with tubercular dactylitis and cold abscesses over the tibia, none was found. I was informed by the natives that the death rate among the children was not high, and the birth rate, so far as it was possible to judge from a visit to the villages, did not appear low. The ages of these children ranged from 6 months to 14 years.

Six miles in a northerly direction from Membakut and about one mile east of the railway the country is entirely different and consists of good high land. Here, situated on the Bangawan River, is Bangawan Village, and the spleen rate of the 69 children examined was only 1·42 per cent. Rubber Estate (B) is situated about two miles

further up the river and there is little malaria among the coolies, in spite of the fact that no prophylactic quinine is taken. The spleen rate of 321 coolies was 7·1 per cent.

Apart from the railway which extends from Jesselton to Melalap, a distance of some 100 miles along the coast, and a few rivers, there is no means of communication, and when writing of travelling from district to district, travelling by rail is meant. From Bangawan, travelling in a northerly direction for about 5 miles and then following the Kimanis River for a further three miles, one reaches Kimanis Village, where among the 52 children examined the spleen rate was found to be 11·53 per cent. The land here for the most part is high and there is no extensive area of swamp. The village is cleaner than is usually the case with native villages and the houses are better built, with wider intervals between them. The jungle in the neighbourhood is not dense and the village itself, with the exception of a few coconut trees, is fairly free of vegetation. Owing to arrangements kindly made for me by the District Officer, the native chief of the district accompanied me round the village and I went into most of the houses. I was informed that the inhabitants at one time had had among them a wasting disease with cough, but with the exception of one boy suffering from emphysema, cough and cyanosis, I found no evidence of tuberculosis. A few rice-fields surround the village.

A further two miles up the river is Rubber Estate (C), where the spleen rate of the 379 coolies was 11·87 per cent. Prophylactic quinine is given. Great care was exercised by the manager to enforce the use of mosquito nets among the coolies, and had this not been so the amount of malaria in the coolie force would have been much greater, for a good many of the lines were situated near a piece of swamp where I found Anophelines breeding. An interesting fact on this estate was that one coolie line built on rising ground in the middle of an extensive swamp, which had large trees growing in it, was, so long as the trees remained standing, infested with malaria, but as soon as the trees were felled, although little could be done to drain the swamp, the malaria stopped. It seems that one explanation possible was that the large trees helped to shield the adult mosquitos when they bred out and that the short undergrowth which remained (as the land was unsuitable for planting) did not afford the same protection.

This observation may also explain the well-known fact on rubber estates that so long as the trees remain small, the malaria rate is small, but as the trees get larger the malaria increases. This phenomenon is sometimes attributed to the mere growth of the trees in itself in some unknown way, but I do not know of any observation tending to show that the size of the rubber trees without the presence of water, either in the shape of pools or small hill streams, has been responsible for malaria.

Twelve miles further north is Papar Village, and in the Mill Hill Roman Catholic Mission there, among 37 children drawn from the village, the spleen rate was 13·5 per cent.

Although the houses are widely separated, this is the most populous district on the west coast of this part of Borneo and there is a large amount of rice-growing. The land is flat and high, with no extensive area of swamp. The jungle may be described as light and is nowhere dense. As is the common experience, cultivated rice-fields do not seem to be a danger in favouring malaria in this district. Not

until Rubber Estate (D) is reached, in a direction almost due east, about five miles distant, does the land become hilly with intervening swamps. Here the native population is small. The spleen rate of the 322 coolies examined on this estate was 25·4 per cent (prophylactic quinine). The spleen rate was taken in the early stage of the development of the estate when there was a good deal of malaria, but after the drainage of the flat land and swamps and careful selection of sites for coolie lines it very much decreased.

All the rubber estates with which this paper deals were young and two only were beginning to produce in 1913.

Without exception, in any jungle or swamp land on the borders of estates, where search has been made, Anopheline larvae have been found, most commonly those of *Anopheles kochi*; and as these particular larvae are found so frequently in association with other Anopheline larvae, a further search would probably reveal the presence of malaria-carrying species. As pointed out by Dr. Watson, of the Federated Malay States, the question of the proximity to estates of jungle or swamp is an important one from the point of view of the planter when sites have to be chosen for the erection of permanent buildings, and it is essential that all buildings to be used as habitations should be placed well within the planted area, where drainage is generally good and properly maintained.

In the experience of the writer no better example of this could be found than on Estate (A), where many of the coolies were housed within a few feet of the large Membakut swamp. Malaria was very prevalent, and in the season occurred almost as an epidemic. The number of cases coming from these lines was three times as many as those coming from lines situated on another part of the estate a long distance from jungle or swamp. From the foregoing account it will be seen that the spleen rate of an estate coolie force corresponds to some extent to the spleen rate of the neighbouring village, and the amount of malaria to the proximity of swamp-breeding malaria-carrying mosquitos.

My reason for going into a good deal of detail with regard to the general conditions of this small area of Borneo is that I believe this part of the world to be little known in medicine.

The following is a list of the species found, and under each I have mentioned as many points as to breeding grounds, habits and occurrence of malaria as I have been able to collect. In most cases the adults have been taken, but a good many specimens have been bred from larvae. No great attention was paid to the characters of the larvae, but a note was generally made as to the kind of water in which they were found and associated conditions. In every case the specimen has been either compared with the type, when obtainable, or with the original description.

The new species has been compared in tabular form with all the known species without spots on the wings, except the American forms. In order to facilitate reference all the synonyms of the other species have been mentioned.

A map and rough plan are appended. The map (Map III) shows the general distribution of the species along this strip of coast, and the rough plan (Map IV) shows the local distribution around estate (A).

It is somewhat noteworthy that eight out of the ten species identified should be found in such a circumscribed area, and this illustrates in a convenient way how an estate can be invaded by mosquitos when situated too near to jungle or swamp.

List of Anophelines Found.

A.—With unspotted wings : *Anopheles brevipalpis* sp. nov.

B.—With spotted wings :

1.—With banded palps, *A. kochi, A. maculatus, A. leucosphyrus, A. punctulatus, A. ludlowi.*

2.—With tip of palps grey, *A. separatus.*

3.—With palps unbanded, *A. barbirostris, A. umbrosus, A. albotaeniatus.*

Anopheles brevipalpis, sp. nov.

A large mosquito, without spots on the wings; anterior cross-vein midway between supernumerary and posterior cross-veins; palps less than three-fourths of the proboscis; abdomen with a shiny appearance above; anterior legs of male with one large claw and one rudimentary, the former with one tooth. *Culex* position assumed at

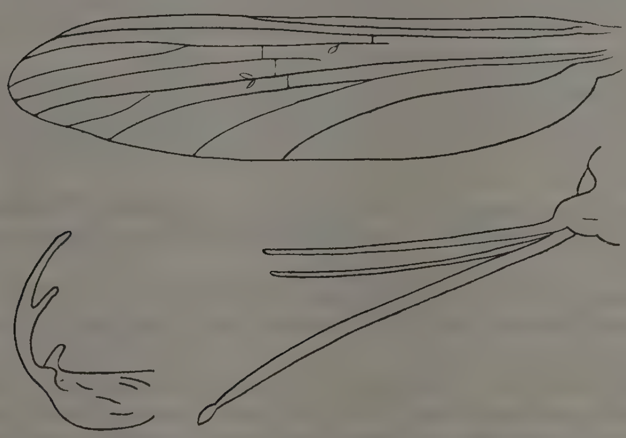


Fig. 1. *Anopheles brevipalpis*, Roper: wing, front claws of ♂, and proboscis and palpi of ♀.

rest. *Head* dark, scales uniform in structure, with free edge broad and finely serrated; these scales light in colour in the middle, dark at the sides. Usual fine tuft of hairs projecting forwards between eyes; fairly stout hairs curving forwards from behind and all round eyes. *Palps* dark, unbanded, rather less than three-quarters the length of the proboscis. *Proboscis* dark, unbanded. *Thorax* without ornamentation. *Scutum* slate-coloured and covered fairly thickly with hairs, a tuft of outstanding scales on pronotum. *Scutellum* slate-coloured with a few stout hairs. *Halteres* with light-coloured knob and dark stem. *Abdomen:* to the naked eye the

upper surface has a shiny appearance in recently killed specimens; covered everywhere with long yellow hairs, and entirely devoid of scales. *Legs* dark-scaled, without banding, long and slender. Anterior legs of male with one large and one rudimentary claw, the larger claw being about three times as long as the smaller, and having one tooth. Coxae and trochanters dark. *Wings* unspotted, lightly covered with scales, which are short and lanceolate. True anterior cross-vein midway between the so-called supernumerary cross-vein and the so-called posterior cross-vein, and all three separated by about the length of a cross-vein. *Length*, 5·5mm.

About 35 specimens of this species were found in the estate (A) hospital, a building situated 150 yards from the jungle and 200 yards from the Membakut swamp. Female specimens predominated. No larvae were found, and the hospital was the only building in which the species was taken. Five specimens were dissected, but none was found infected. January, June, April and December, 1913, were the months in which they were taken. The description is based on four females and two males.

The types have been deposited in the British Museum.

The other Old World *Anopheles* which have unspotted wings may be distinguished from *A. brevipalpis* by the following characters :—

A. bifurcatus has the free edge of the head scales distinctly forked; palps nearly as long as the proboscis; abdomen slatey brown; legs shorter and thicker, the anterior tarsi of ♂ with only one simple claw; wing scales long, lanceolate; anterior cross-vein internal to the supernumerary and posterior cross-veins.

A. barianensis, James and Liston, has both flat scales and upright forked scales on the head; palps as long as the proboscis; thorax ornamented with scaling; coxae and trochanters light; anterior cross-vein in a line with the supernumerary cross-vein, the posterior one internal to these.

A. culiciformis, James and Liston, has some spindle-shaped scales on the head and no projecting tuft of hairs; palps as long as the proboscis; anterior legs of ♂ with one simple claw; cross-veins almost in a line.

A. algeriensis, Theo., has the head scales distinctly forked; palps nearly as long as the proboscis; abdomen not shiny; costal margin of wing with a slight dip in the centre; length 3·8–4·5 mm.

A. immaculatus, Theo., head scales forked; palpi almost as long as the proboscis; legs banded; anterior tarsi of ♂ with the claws equal and simple; anterior and supernumerary cross-veins in a line, posterior one internal to these by three times its length.

A. aitkeni, James and Theo.; head with narrow forked and spindle-shaped scales, and no tuft of hairs; palps as long as the proboscis; anterior cross-vein external to the supernumerary and posterior cross-veins.

Anopheles kochi, Dön.

Anopheles kochii, Dönitz, Insectenbörse, Jan. 1901, p. 1, and Zeits. Hyg. u. Infekt. Krank., 1902, p.67.

Christophersia halli, James, Rec. Ind. Mus., 1910.

This is by far the commonest Anopheline found in the district. Specimens were bred out from the large Membakut swamp, swampy land near estate (C), a small

sago swamp at Bangawan, and from the jungle on the borders of estate (D). At different times adults were taken in the houses on estate (A) close to the swamp, and in one house on estate (D), though the numbers were never great. No definite outbreak of malaria could be ascribed to he presence of this mosquito, but *Anopheles barbirostris* and *Culex mimeticus* were often found breeding in the same pools. Larvae were found all the year round, being most abundant between May and October. When found alone, the larvae of *Anopheles kochi* seem to prefer small collections of water without vegetation, most commonly those present in the hoof-marks of cattle. Eight specimens were dissected, but no malarial parasites were found. In those bred from larvae, and also in the captured adults, females always predominated.

Anopheles maculatus, Theo.

Anopheles maculata, Theobald, Monogr. Culicid. i, p. 171, 1901.

Nyssorhynchus maculatus, Theobald, *op. cit.*, iii, p. 96, 1903.

Nyssorhynchus willmori, James, in Theobald, *op. cit.*, iii. p. 100, 1903.

Neocellia dudgeoni, Theobald, *op. cit.*, iv, p. 113, 1907.

Only three specimens of this mosquito were bred from larvae, all being males. The larvae were found in the same pool and at the same time as those of *Anopheles leucosphyrus* (Oct. 1913), near the small hill stream on the borders of estate (A). The water was clear, and although close to the stream, had no direct communication with it.

In view of the work of Stanton and Watson in the Federated Malay States, which shows that this species is a carrier of malaria, the finding of it in Borneo is of some importance to the rubber estates there, as many of them have hill streams favourable to the breeding of this mosquito.

Anopheles leucosphyrus, Dön.

Anopheles leucosphyrus, Dönitz, Insectenborse, Jan. 1901, and Zeits. Hyg. Infekt. Krank., p. 56, 1902.

Myzomia elegans, James, in Theobald, Mon. Culic., iii, p. 51, 1903.

Anopheles "*leucophyrus*," James, Monog. Anoph. India, p. 82, 1904.

Pyretophorus elegans, Theobald, *op. cit.*, iv, p. 77, 1907.

Myzomia "*leucophyrus*," Leicester, Stud. Inst. Med. Research, F.M.S., iii, p. 28, 1908.

Neomyzomia elegans, James, in Theobald, *op. cit.*, v, p. 30, 1910.

The Borneo specimens are identical with Dönitz' original description.

This species was first found on the outside of a coolie line on estate (A), situated about 150 yards from the swamp, in July 1913. I was led to examine this line carefully on account of the occurrence of many cases of malaria there, and two days later specimens of this mosquito were taken. From July until the end of November specimens were constantly found in the nets of the coolies in the early morning. These were all gorged with blood and it was difficult to find a specimen which had not recently fed on a coolie. During these months cases of malaria were constantly coming from this line, as many as six and eight in a day. On one occasion one specimen of *Anopheles umbrosus* was taken. Many of these cases I looked upon as relapses,

but many also were men who had not been in hospital for malaria for over a year, and I felt justified for this reason in looking upon them as fresh infections. During the months of July, August and September, 1913, there were in all 62 cases, 33 of which were relapses and 29 fresh infections. In all the cases a search was made for the parasite, which was found in the majority, in spite of prophylactic quinine having been given daily. The actual figures for the fresh infections were as follows :—

Benign tertian parasites alone	13
Subtertian alone	3
Benign tertian with subtertian	2
No parasites found	11

The relapses were most persistent, in spite of daily quinine, after efficient treatment in hospital for a varying period of ten to fourteen days.

About 50 specimens were taken in all; females predominating. In October 1913 many cases of malaria occurred among the coolies on estate (A) who were working at a dam in the jungle on the borders of the estate. Among these cases again there were many relapses, but fresh cases also occurred. It must be mentioned that coolies who had recently been in hospital with malaria were working with coolies who had not been in hospital for malaria for over a year. A search was made in the neighbourhood of the dam for the breeding places of Anophelines and in a pool made in excavating clay about 150 larvae were found, which, after breeding out, proved to be *Anopheles leucosphyrus* and three specimens of *Anopheles maculatus*.

It was along the borders of this stream that the one specimen of *Anopheles umbrosus* was taken, as mentioned later under that species. At this time no *umbrosus* was found and although a prolonged search was made for larvae none were discovered in the stream.

Anopheles leucosphyrus seems to breed either in clean or dirty water, and larvae were found in swamp water with much scum on the surface, near the line previously mentioned, as well as in clean pools and in old cement barrels.

Seventeen specimens were dissected, but in only one instance was it possible to dissect the stomach, as in the other cases this organ was full of blood.* The salivary glands were dissected in the other mosquitos in the hope that sporozoites, the result of a previous meal of infected blood, might be found, but none were discovered. Although from the facts recorded no definite conclusion can be drawn as to the malaria-carrying powers of this species, I think the evidence is suggestive.

Anopheles punctulatus, Dön.

Anopheles punctulatus, Dönitz, Insectenbörse, Jan. 1901, and Zeits. Hyg. Infeckt. Krank., p. 57, 1902.

Anopheles punctulatus, Theobald, Mon. Cul. i, p. 175, 1901.

Myzomia tessellatum, Theobald, *op. cit.*, i, p. 175, 1901, and iii, p. 55, 1903.

Nyssomyzomyia punctulata, James and Liston, Anopheline Mosquitos of India, 2nd ed., p. 104, 1911.

The Borneo specimens correspond with those labelled *A. tessellatus* in the British Museum in having four white bands (including the tip) on the palps, and not five as

* Many attempts were made to keep the insects alive until the blood was digested, but they all died.

in *punctulatus*.* The banding of the palps seems to be the only difference between these two mosquitos; in *punctulatus* the arrangement of the bands from tip to base is: white tip, black band, broad white band, black band, narrow white band, black band, narrow white band, broad black band, narrow white band, rest black; in *tessellatus* the bands are: white tip, black band, broad white band, black band, broad white band, broad black band, narrow white band, rest black.

This species was found inhabiting the estate (A) hospital and one of the houses near the Membakut swamp. About 30 specimens were taken, but no larvae were found. The time of capture was April, May and July, 1913, females predominating.

Anopheles ludlowi, Theo.

Myzomia ludlowi, Theobald, *op. cit.*, iii, p. 42, 1903.

Nyssomyzomia ludlowi, James and Liston, *op. cit.*, p. 101, 1911.

Two specimens only (both females) were found; one in a coolie line on a coconut estate at Kuala Lama, about six miles west of Membakut, in December 1912; and the other in one of the houses on estate (D) at Papar, in April 1913.

Sixteen cases of subtertian malaria had been admitted from the line in question and this species was the only one observed in the neighbourhood. No larvae were found.

Anopheles separatus, Leic.

Anopheles separatus, Leicester, Stud. Inst. Med. Research, F.M.S., iii, pt.3, p.36, 1908.

A careful comparison of ten females and two males with Leicester's types in the British Museum makes it clear that the specimens taken in Borneo belong to the same species. The points I would emphasise as being very constant and sufficiently differentiating it from the species it most resembles, namely *A. sinensis* and *A. umbrosus*, are as follows: the palps have dirty grey tips; in the wings the middle spot always extends on to the first longitudinal vein; yellow spot on first longitudinal vein always confined to this at the junction of inner third with outer two-thirds of wing; yellow spot on fringe between lower branch of second longitudinal vein and third longitudinal vein; predominance of light scales; absence of apical ventral tuft on the abdomen. I should add that in two out of the ten females there was in the palps a faint suggestion in one case of one additional ring, and in the other of two additional rings. In the male the expanded portion of the palp is dirty grey, with a light brown thin band in the centre.† In spite of these small deviations the other characters were constant.

Adult specimens were taken in the houses on estate (A) and in the estate (A) hospital; one specimen came from the Rest House in Jesselton. It is not a common species and only about twenty specimens were obtained, females predominating. One female was bred from a larva found in the Membakut swamp. No note was made as to the characters of the larva.

* [According to Mr. F. W. Edwards, *A. tessellatus* is a purely Oriental species, it being represented in the Australasian region by *A. punctulatus* (Bull. Ent. Res. iv, 1913, p. 221.—Ed.]

† This point shows in Leicester's types, but is not mentioned in his original description.

Explanation of Reference Figures in Map III.

The numbers indicate the occurrence of the following species :—

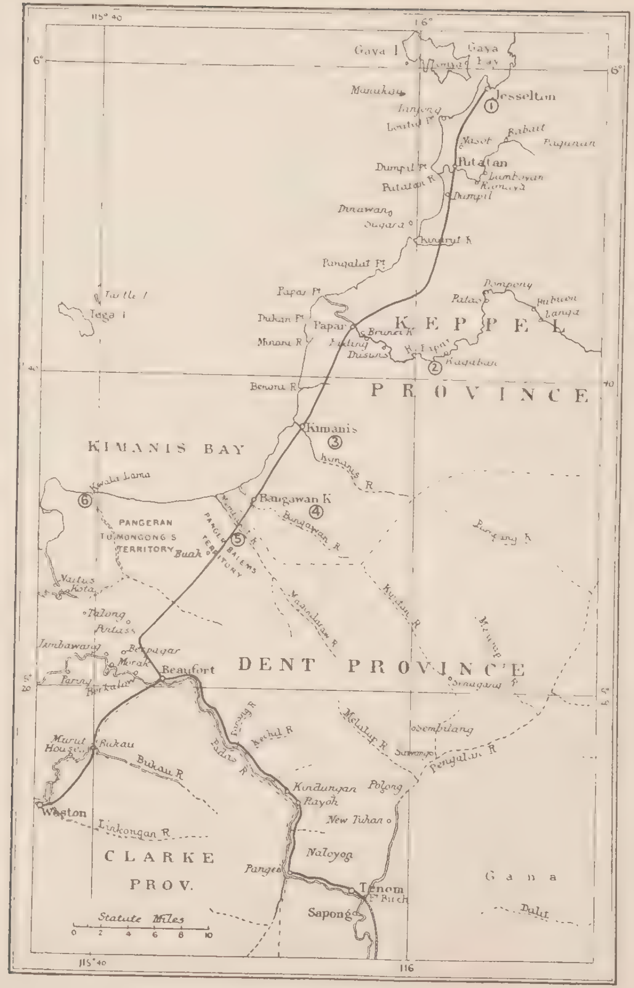
(1) *Anopheles separatus.*

(2) ,, *kochi* ; *A. ludlowi.*

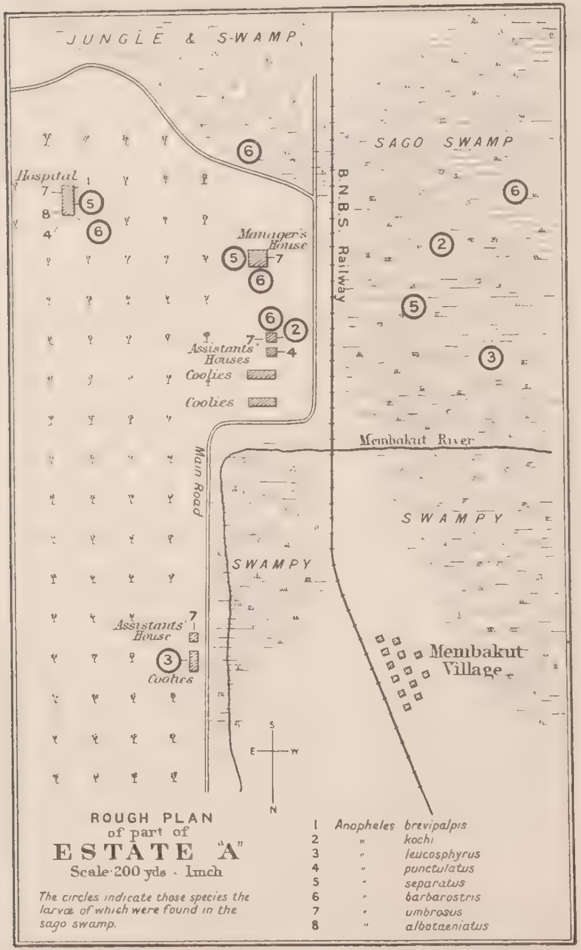
(3) ,, *kochi* ; *A. umbrosus.*

(4) ,, *kochi.*

(5) ,, *kochi* ; *A. brevipalpis* ; *Anopheles umbrosus* ; *Anopheles barbirostris* ; *Anopheles punctulatus* ; *Anopheles leucosphyrus* ; *Anopheles albotaeniatus* ; *Anopheles separatus.*



SKETCH-MAP OF THE WESTERN COAST OF BRITISH NORTH BORNEO.


JUNGLE & SWAMP
SAGO SWAMP
Hospital
Manager's House
Assistants' Houses
Coolies
Coolies
B.N.B.S. Railway
Main Road
Membakut River
SWAMPY
SWAMPY
Assistants' House
Coolies
Membakut Village
S
E
W
N
ROUGH PLAN
of part of
ESTATE "A"
Scale 200 yds - 1 inch
The circles indicate those species the larvae of which were found in the sago swamp.
1 Anopheles brevipalpis
2 " kochi
3 " leucosphyrus
4 " punctulatus
5 " separatus
6 " barbarostris
7 " umbrosus
8 " albotaeniatus

AUSTRALASIAN HISPIDAE OF THE GENERA BRONTHISPA AND PROMECOTHECA WHICH DESTROY COCONUT PALM FRONDS.

By Walter W. Froggatt, F.L.S.,
Government Entomologist, New South Wales.

With the increasing demand for copra all over the world for the production of coconut oil, the cultivation of coconut palms has increased enormously during the last ten years in the Solomon Islands, New Britain, Papua, Samoa, and the New Hebrides, and large areas of virgin forest have been cleared and planted on regular scientific principles. In olden times most of the nuts were collected from the native plantations, where the palms were grown under almost wild forest conditions, and were then more hardy and did not suffer to the same extent from insect pests as do the palms planted under modern conditions. It is probable that the increased food supply, represented in the fronds of the thousands of young coconut palms planted out, has been responsible for the enormous increase of a number of indigenous leaf-eating beetles, which, under the conditions previously prevailing, lived upon the wild coconut and other species of palms growing in the jungle. In addition to many insect pests allied to or identical with those known in Ceylon, India, and the Malay States, we have in these Eastern islands a number of leaf-destroyers in the small flattened beetles belonging to the family Hispidae. The larvae of these beetles feed either on the upper surface, or in the tissue of the leaf under the protection of which they finally pupate, so that one can sometimes obtain the whole life-history from the egg to the perfect insect in a single palm frond. The majority of these leaf beetles, which are causing so much damage in the coconut plantations, belong to the genus *Promecotheca*, Blanchard, and from what we know of the life-history of several species that have become serious pests, it is fairly safe to assume that the habits of all the species are similar.

The described species given by Weise in the "Genera Insectorum" (1911) number 15, and range from China to the New Hebrides. The following ones occur in the area under survey, and notes are given upon those that have been recorded as pests of coconut palms. The life-histories of the different species of this genus are so similar that it is here only necessary to give that of a typical one, and I have selected for this purpose the species in the New Hebrides, which has done such an enormous amount of harm during the last few years to the coconut plantations.

The New Hebrides Coconut Hispid (*Promecotheca opacicollis*).

This insect is known among the planters as "the Blight," "the Fly," or "the Beetle Pest" of the coconut palm, and is said to have been noticed by some of the settlers in the islands over 50 years ago. About 1905 they were first recorded in the Northern Islands of the group, damaging palms in the cultivated plantations, and three years ago there was a regular plague of them all over the islands, from Sandwich to Santo. At the request of a number of planters interested, I paid a visit to the New Hebrides in June 1913, and spent over a month among the coconut plantations studying the insect pests, and this beetle in particular.

The damage done is twofold; first, that caused by the larvae; and secondly, that caused by the adult beetles. The beetles lay their eggs in little clusters of five

upon the under surface of the palm frond, covering them with a little mound of chewed-up fibre. Under this protection the larvae hatch out and gnaw their way between the two layers of the leaf, feeding as they go, until they have excavated a regular gallery, forming a brown blister up to six inches in length and half an inch in width. When fully fed the larvae pupate at the end of excavation. The elongated blisters in the fronds shrivel up and, when numerous, the whole frond is destroyed. The beetles, however, do more damage than the larvae, because while swarming over the under surface of the leaves, and also while laying their eggs, they feed upon the fronds, gnawing long parallel furrows down the centre. Besides the damage caused by the beetles and their larvae, each of these damaged fronds becomes a centre of infection for the fungus diseases which are so prevalent in the tropics. Each frond dies back to the mid-rib or main stalk, which turns brown and decays down to its junction with the trunk of the palm. Behind the basal fronds are produced the flower spathes, afterwards replaced by the bunches of coconuts, and when these fronds fall from the trunk, the coconuts as they increase in size are unable to sustain their own weight, and are, therefore, torn off from the attachment to the stem of the palm, and fall to the ground while still immature and of no commercial value.

Therefore, after the beetle infestation, the crop is very poor, unless the coconuts happen to have been well matured before the beetles attacked the foliage. In the season following an attack by Hispids the coconut palms, denuded of all these lower leaves, have to grow a fresh crop of foliage before they can put forth fresh flower spathes; the annual output is thus less than that of the previous year, and often it is not until the following season that the coconut palms have absolutely regained their former vigour. It is frequently stated by the planters that the palms are killed outright by these beetles. But the coconut is a very hardy tree, and as long as the terminal leaf-buds are uninjured they will put forth fresh leaves and recover sooner or later from the attacks of the beetles, unless these are followed by a continuous drought or other abnormal conditions, when the enfeebled palms cannot withstand the additional strain.

The Fiji Coconut Hispid (*Promecotheca cocruleipennis*, Blanchard).

This is the type of this genus of destructive beetles, and was described from Fiji by Blanchard from specimens obtained during the voyage of the "Astrolabe," which was sent out by order of the King of France on a scientific expedition in 1837-40. The insect is described and figured in the Zoology of the expedition published in Paris in 1853. From Blanchard's figure and description this appears to be the common leaf Hispid of the coconut in Fiji, although in Jepson's report it is identified as *Promecotheca reichii*, a species which, according to Gestro, may be a variety of *P. coeruleipennis*.

Jepson has described and figured the life-history of this insect, and states that it has only been found upon a few of the islands. It is therefore a local pest, and is not, like the New Hebrides species, spread all over the group, though its life-history and habits are identical. It is abundant in March and April, but is heavily parasitised in the egg, larval and pupal stages. The parasite, which is a different hymenopteron from that which is found attacking the eggs of the Leaf Hispa of the New Hebrides, seems to be a useful check upon its increase in Fiji.

The beetle is smaller than *P. opacicollis* and differs in having the antennae light-coloured on the basal joints, with the head (except the eyes), thorax, legs and basal third of the wing-covers yellow and the hind two-thirds of the wing-covers deep metallic purple to blue.

The Solomon Is. Coconut Hispid (*Promecotheca antiqua,* Weise).

The writer did not notice this beetle during his visit to the Solomon Islands, but subsequently received a number of specimens from Bougainville. It had been previously recorded from New Britain and German New Guinea, where it is known as a leaf pest of the coconut palm. Closely allied to *P. opacicollis* in size and general form, it differs in having the basal joints of the antennae more ferruginous, the head and thorax black, the wing-covers more rugose, not so deeply striated, of a uniform light colour for the first three-quarters and the apical quarter black.

The Queensland Coconut Hispid (*Promecotheca callosa,* Baly).

This species is found in Northern Australia upon native palms. There are several specmens in the Macleay Museum collections from Cape York, Queensland. It measures slightly over one-third of an inch in length and is somewhat broader across the shoulders than most of the species previously noticed. The head, thorax, antennae, and under surface are black, with only the tips of the tarsi golden yellow. The elytra are yellow, swelling out on the front margin, but of a uniform width, broadly rounded to the tips, and ornamented with eight parallel striae on either side, impressed with small deep contiguous punctures. Nothing has been recorded of the habits or exact food-plant of this beetle.

The Port Darwin Coconut Hispid (*Promecotheca varipes,* Baly).

This species is represented by several specimens in the Macleay Museum. Mr. Lea informs me that there is a specimen in the Adelaide Museum from the same locality (Port Darwin, N. Australia) obtained upon the foliage of Pandanus.

About the same size as the previous species, it has the head, thorax, fore legs and elytra yellow; the tarsi, the junction of the femur and tibia of the fore legs, the antennae, the middle and hind legs, and the under surface black. The thorax is deeply constricted by three transverse rounded ridges, the central one the broadest. The elytra swelling out in front, broadly rounded to the apex, with similar parallel striae, but the punctures deeper than in *P. callosa.*

Two species have been described from German New Guinea by the Hungarian Entomologist, Csiki, *Promecotheca biroi* and *P. papuana,* but neither has as yet been recorded, so far as I know, as a pest of coconuts.

The Leaf-bud Hispa (*Bronthispa froggatti,* Sharp).

The larvae of the beetles of this genus are not leaf-miners, but feed with the adult beetles upon the epidermis of the opening leaf-buds, protected in the half-folded fronds. This species is included here as it has done a great deal of damage and caused much extra expense in the work of looking after the young coconut palms in the plantations in many parts of the Solomons.

The beetle, larvae and pupae may be all found together in the same palm frond, so that their life-history can be easily studied. Both the beetles and larvae gnaw

the surface of the leaf, which, as it expands, shows large blackened areas through the damage thus caused ; and where the leaves are badly infested they keep dying back one after another, so that the growth of the palm is seriously retarded.

Originally described from specimens sent to Dr. Sharp by me and obtained in plantations in New Britain, this beetle was found a few years later swarming in the coconut plantations in the Solomon Islands It has, however, a still wider range, for last year (1913) I discovered it in many parts of the New Hebrides, where it was usually to be found in the fronds of any small, sickly or damaged tree, but was not a pest on healthy cultivated palms, as it was in New Britain and the Solomon Islands.

The beetle is slender, almost cylindrical in the body, and tapering at the tip of the abdomen ; from the tip of the antennae it measures up to half an inch in length. General colour shining black, with the thorax and fore pair of legs dull yellow, the second pair marked with yellow. The small head is produced in front into a lance-shaped projection between the antennae ; the thorax almost square, slightly hollowed out on the sides, and curved round in front behind the eyes. The slender body is covered with stout black wing-covers, deeply ribbed with finely punctured striae, depressed and rounded at the extremities.

At first the chief method adopted in dealing with these beetles and their larvae was to apply a tobacco and soap wash. This was effective when shaken or sprayed into the infested fronds, but the difficulty was to see that the native boys did the work properly. Afterwards and at the present time, when "beetling" is carried out, the tips of the infested fronds are cut off as soon as noticed and burnt with the eggs and larvae before they have spread downwards to damage the whole of the young leaf.

TWO NEW SPECIES OF FRUIT FLIES FROM SOUTHERN INDIA.

By Prof. M. Bezzi,
Turin, Italy.

Bactrocera (Chaetodacus) bipustulata, sp. n.

Very nearly allied to *B. scutellaris*, Bezzi (*Memoirs of the Indian Museum*, iii, 1913, p. 98, pl. viii, fig. 10), but differing in its smaller size, black face, differently coloured scutellum and unicolorous wings. This last character distinguishes it at once from any other Oriental species of this genus at present known.

♂. *Length* of body, 5 mm.

Head exactly as in my description of *B. scutellaris*, with the following differences :—the lunula is black ; the face is entirely of a shining black colour, instead of yellow with two black spots. Thorax with no dorsal yellow stripes behind the suture, and only a very short stripe on each side laterally ; the other yellow markings are as in *scutellaris*. Scutellum black, adorned with two very broad, bright orange spots, one on each side ; or it might be described as bright orange, with a broad median longitudinal black band ; the basal pair of bristles is placed near the base of the yellow spot, the apical pair is placed on the sides of the black stripe. *Abdomen* entirely black, even on the venter ; there is a dark yellow transverse band on the hind border of the second segment, and sometimes there are two less distinct brownish-yellow spots on the middle of the hind border of the third and fourth segments. *Legs* as in *scutellaris*, but the front femora are almost entirely black ; middle tibiae and tarsi wholly yellow. *Wings* hyaline and without any dark pattern ; only the stigma is of a dark yellowish colour ; anal cell a little infuscated towards the end of its prolonged point. *Type* ♂ and another specimen from Mysore, 4,100 feet, Arabidacool, Estate, 25th March—29th April 1913.

2. **Monacrostichus crabroniformis,** sp. n.

A very distinct species, which shows the characters of my genus *Monacrostichus* (see *Philippine Journal of Science*, viii, 1913, p. 322), having long and porrect antennae and the abdomen club-shaped ; but the front femora are not spinose beneath.

♂. *Length* of body, 5·5 mm ; of antenna, 1·5 mm.

Head partly yellow ; occiput black, with a narrow complete yellow circle around the eyes ; frons brown, with a yellow spot near the vertex on each side of the ocelli, and a small arcuate yellow band above the lunula, which is black ; cheeks small and yellow, face wholly shining black ; jowls yellow, with a dull black spot. Antennae porrect, much longer than the face ; the first two joints are yellow, rather long and of equal length ; the last joint is a little shorter than the first two joints together, dark brown, a little yellowish towards the base ; the arista is thin, nearly as long as the third joint ; palpi yellow. *Thorax* black, densely punctate, with the following markings yellow :—humeral callosities ; a narrow stripe along the transverse suture, broadly interrupted towards the middle ; a fascia on the mesopleura, extending from the transverse suture, where it is in contact with the dorsal stripe, to the upper part of the sternopleura, and there forming a very small dot ; and a broad spot on the hypopleura. Scutellum entirely yellow, with a narrow black band at the base. Chaetotaxy : there are no praescutellar bristles, and the anterior supra-alar

bristle is indicated only by a hair; no acrostichal bristle; scutellum with only the apical pair of bristles. All the bristles, like those of the head, are black. Mesophragma black, unspotted. Halteres yellow. *Abdomen* very strongly stalked, clothed with rather long whitish hairs, which on the sides are very long; it is black and punctate like the thorax; the second segment has two yellow bands, one near the fore border and one on the hind border, the latter interrupted towards the middle; third segment entirely black and without rows of bristly hairs on the sides; fourth with two less distinct dark yellow spots on the middle near the hind border; fifth with a rather broad yellow hind border. Genitalia small and yellow; venter black. *Legs* black, with yellow tibiae and tarsi; front femora without spines beneath, almost entirely black; middle femora narrowly yellow at the apex; hind femora with more than the basal half of a light yellow colour; hind tibiae a little infuscated near the tip. *Wings* hyaline, a broad brown band from the base to the end of the third longitudinal vein, but the costal cell wholly hyaline; the marginal and submarginal cells are entirely filled with brown, the colour extending a little into the first posterior cell towards the hinder half of last portion of the third longitudinal vein; stigma darker, anal cell entirely hyaline to the end.

Type ♂, a single specimen from Yerkaud, Shevaroy Hills, 21st April—20th May 1913, 4,500 feet.

In the same small collection of Indian fruit-flies, forwarded by Mr. E. Ballard, Government Entomologist, Coimbatore, there are two other very interesting species:—

Leptoxyda longistyla, Wied.; two male specimens from Coimbatore on *Calotropis*, 6. x. 1913 (*T. B. Fletcher*). These specimens agree very well with those from Erythraea, Kassala and Senegal in my collection. The species has evidently been imported from tropical Africa, with the plant on which it is always to be found, *Calotropis procera* (*cf.* Bezzi, *Mem. Ind. Mus*, iii, 1913, p. 92).

Dacus brevistylus, Bezzi; two male specimens from Siddhout, Cuddappale, on melon, April 1910. This is also an African species, which is widely distributed in the ~~European~~ region, being a serious pest of melons (*cf.* Silvestri, *Boll. Labor. Zool. gen. e agr., Portici*, viii, 1913, p. 94, fig. 2 and *Bulletin* no. 3, *Div. Entom. Hawaii*, 1914, p. 93, pl. viii, fig. 27). This is the first time that the species has been recorded from India.

DESCRIPTIONS OF FIVE NEW SPECIES OF ANOPLURA AND MALLOPHAGA.

By Bruce F. Cummings,
*British Museum (Natural History).**

The following systematic work was carried out in the Entomological Department of the British Museum and is based on material in the National Collection. An endeavour has been made to extend the area of the field usually covered by the systematist in his search for characters, although the author is well aware how far short of the ideal in this matter the paper falls. The species described are :—

Anoplura.

Haematopinus taurotragi, sp. n. *Linognathoides spermophili*, gen. et sp. n.

Mallophaga.

Colpocephalum mjöbergi, sp. n. *Goniocotes waterstoni*, sp. n. *Menopon robsoni*, sp. n.

Haematopinus taurotragi, sp. nov. (figs. 1, 2).

In the collection of carded material mounted dry, a large series of *Haematopini* was found, labelled : "From the Eland, *Boselaphus oreas*, Knowsby Menagerie, 1857." In spite of their age and dried condition, these specimens made excellent preparations, from which the description below is drawn up.

H. taurotragi belongs to the "*tuberculatus*" group founded in 1851 by Lucas (1)† with the description of *H. tuberculatus*. Subsequently, Piaget (3) described a variety of this species under the name *penicillata*, which, as Neumann (2) points out, is probably no other than *H. eurysternus* (Nitzsch).

Thus, starting with *H. tuberculatus* and *H. eurysternus*, we must include in the group the doubtful species of Rudow, *H. punctatus* (4), the perfectly distinct form, *H. bufali* (Geer)—the same perhaps as Gervais' *H. phtiriopsis*—and the new species now under consideration.

Below is a list :—

Parasite.	Host.
H. tuberculatus (Burm.).	*Bos bubalus*, "*Bos americana*," *Camelus dromedarius* (2), "Chinese Water Buffalo" (5).
H. eurysternus (Nitzsch).	*Bos taurus*.
H. bufali (Geer).	*Bos caffer* (2).
H. punctatus, (Rudow).	*Bos grunniens* (6).
H. phtiriopsis (Gervais).	*Bos caffer* (6).
H. taurotragi, sp. n.	*Taurotragus oryx*.

External Form, Male and Female.—A description of those characters only in which this species differs from *H. tuberculatus* is sufficient. In *H. tuberculatus* the sternal plate is quadrilateral, with the anterior angles projecting a little ; in the

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†For references see page 176.

parasite from the eland the sternal plate is a sexually dimorphic character, and in the male exhibits the form illustrated in fig. 1 *b*, with which may be compared the sternal plate of the female (fig. 1 *c*).

On the male genital plate a transverse row of hairs is present, usually four in number. Midway, each lateral margin is deeply incised so that the anterior half of the plate is in part separated from the rest. Both sternal and genital plates are somewhat variable characters in the male of *H. tuberculatus* and they are by no means

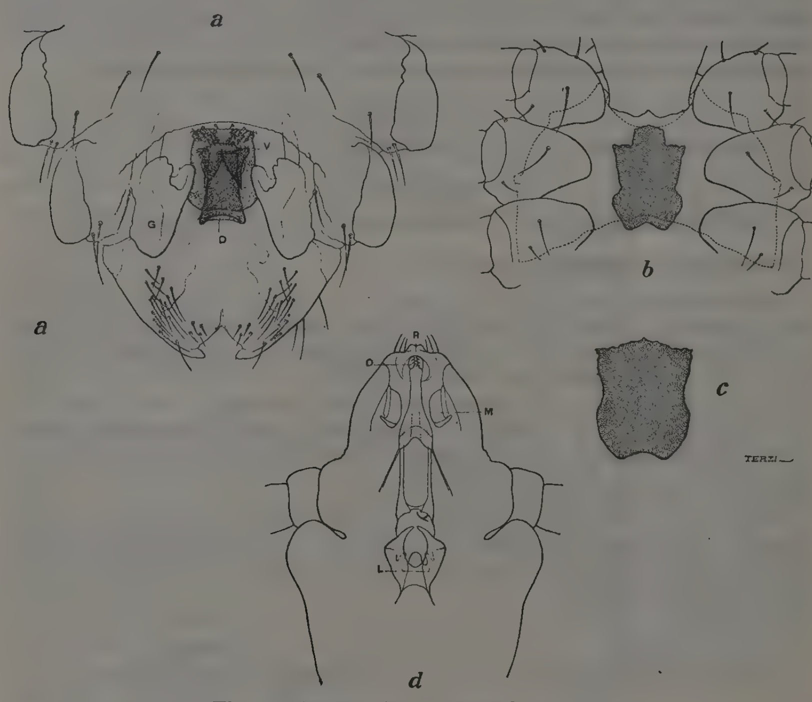

Fig. 1. *Haematopinus taurotragi*, sp. nov.

(*a*) Terminal abdominal segments of ♀, underside: D, dorsal plate: G, gonopod (the elongate hairs on the margin are omitted); V, ventral plate.—(*b*) Thoracic sternite of ♂.—(*c*) Thoracic sternite of ♀.—(*d*) Mouth-parts: D, rostral denticles; L, larynx; M, mandible; R, rostrum; the needle-like trophi are omitted.

constant in the form now under consideration. But the male sternal plate of the one never approaches the form shown in the other, and it may be said that, as a rule, the row of hairs on the genital plate in *H. tuberculatus* consists of more than four, while the lateral incisions are less deep.

The female genital plates offer very excellent distinguishing characters. They are two in number, in the position and of the conformation indicated in the figure. In *H. tuberculatus* the ventral plate of the female is in the form of a fleur de lys.

Chaetotaxy, Male and Female.—Along the temporal margin of the head are two widely spaced hairs; in *H. tuberculatus* there are 3 or 4 moderately long hairs in this position fairly close together. On the abdomen, the lower side of each pleural angle possesses 2 small hairs; in *H. tuberculatus* in the same position there is a row of 9 or 10 closely placed hairs.

Mouthparts.—In fig. 1 *d*, will be found the pair of structures lying one on each side of the pharynx inside the head called by Enderlein (7) mandibles. It is not possible here to enter upon the much-discussed question of the homologies of the Anopluran

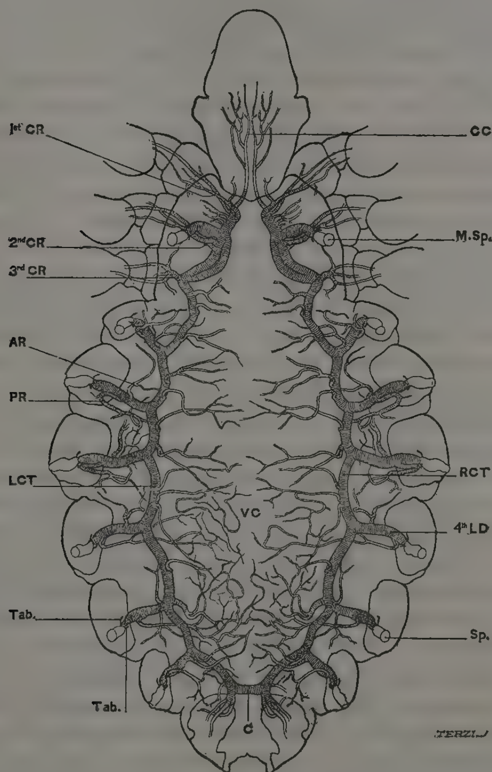

Fig. 2. Tracheal system of *Haematopinus taurotragi*.

AR, anterior root; C, commissure; CC, cephalic complex; CR, crural roots; LCT, left cardinal trunk; 4th LD, 4th lateral diverticulum; M.Sp., mesothoracic spiracle; PR, posterior root; RCT, right cardinal trunk; Sp., spiracle; Tab., chitinous tab of spiracle; VC, visceral complex.

mouthparts and particularly of the needle-like trophi used by these blood-sucking insects for piercing the skin. But the opportunity is taken to point out that the "mandibles" are well developed and quite visible through the integument without the aid of dissection. The chitinisation of the pharynx is very complex. The fulturae are small.

Tracheal System (fig. 2).—The systematic value of the tracheal system will only emerge after more prolonged study. Not much is known at present about it, but in view of such information as we already have at our disposal, it is tempting to hazard the opinion that well marked generic, if not specific, characters will be found, and that in the ultimate classification of these insects this important system, together with the others, will be drawn upon to give at least its tittle of evidence in the difficult questions of phylogenetic affinity.

In *H. taurotragi* the system consists of two cardinal trunks situated longitudinally one on each side, and connected by a commissure at the posterior end of the abdomen. Each cardinal trunk gives off (in the abdomen) 6 lateral diverticula running out to the spiracles. In the thorax there is one large lateral diverticulum which runs up dorsally to the single mesothoracic spiracle. This diverticulum exceeds the main trunk itself in girth. There is an enormous visceral complex formed by the ramifying branches of roots arising from the cardinal trunks. Another large complex exists in the head, formed by the cephalic branches. In the male the commissure runs across the posterior end of the abdomen, dorsal to the genitalia, just below the level where the parameres articulate with the basal plate. In the female the commissure runs across the genital plate. With the exception of the last, each lateral diverticulum of the cardinal trunk gives off two branches, one anterior and the other posterior, the latter being the larger. Other roots arising from the cardinal trunks in the abdomen are shown in fig. 2. As regards the origin of the smaller roots, the tracheal system does not show a symmetrical arrangement on each side.

In the thorax we find a large trunk given off to the third pair of legs, which divides into two and then into still smaller divisions. Two branches likewise supply the second pair of legs, but each of these arises separately. Just in front of these the large trunk to the mesothoracic spiracle is given off. A commissure accompanies the cardinal trunk along its inner side from the base of the branch to the third pair of legs, anastomosing again with the main trunk in front, just at the point where the trunk gives off the branch to the mesothoracic spiracle. This commissure gives origin to no smaller branches. Each cardinal trunk terminates in the prothorax by trifurcating into three relatively small branches, two of which go to the first pair of legs and one to the head. Their method of origin is displayed in fig. 2.

The spiracles present some features of interest. Mjöberg (6, p. 217) has figured and described the spiracles and closing apparatus in several different species of Anoplura. From these figures, it will be seen that the various species differ sometimes very considerably in regard to these characters. In all of them, and in *H.tuberculatus* as well, the spiracular chamber shows the same essential features, i.e., a narrow neck and a single chitinous "tab" standing off from the neck and giving attachment to the muscle of the closing apparatus. But in *H. taurotragi* these "tabs" are two in number, one on each side of the neck. Each abdominal spiracle opens at the extreme lateral margin of each segment. The somewhat concave pleural plate lies on the ventral surface of the pleural area and the spiracular chamber lies in this concavity and can be seen from above through the transparent dorsal integument.

Male Copulatory Apparatus.—This agrees closely with the figure given by Mjöberg (6, p. 231) for *Haematopinus phtiriopsis*. That is to say, the parameres are united

at their distal ends and the chitinisation of the preputial sac is markedly asymmetrical, particularly at the junction with the basal plate. The chitinous "leiste," marked "X" in Mjöberg's figure of *H. phtiriopsis*, in *H. taurotragi* curls round the ends of the parameres and extends partly up the other side of the preputial sac. There is no penis.

Measurements of HAEMATOPINUS TAUROTRAGI *in millimetres.*

	♂		♀	
	Length.	Breadth.	Length.	Breadth.
Head	·7	·5	·8	·55
Thorax	·725	1·5	·7	1·25
Abdomen..	2·4	1·5	2·8	2·25
Total	3·825		4·3	

	♂			♀		
Length of legs	1st	2nd	3rd	1st	2nd	3rd
Femur	·4	·4	·45	·33	·33	·33
Tibia + tarsus	·6	·55	·75	·55	·55	·55
Claw	·25	·2	·35	·25	·3	·25
Total	1·25	1·15	1·55	1·13	1·18	1·13

	♂	♀
Length of Segments of Antenna.		
1	·11	·09
2	·11	·081
3	·11	·07
4	·09	·07
5	·12	·09
Total	·54	·401

Linognathoides, gen. nov.

This new genus is instituted to include specimens of a new form of louse presented to the British Museum by the Hon. N. Charles Rothschild and collected in Transcaspia by W. Koshantchikov on two different hosts, viz., *Cricetus phaeus*, now known as *Cricetulus phaeus* (Pallas), belonging to the subfamily Cricetinae, family Muridae, and *Spermophilus leptodactylus*, now known as *Citellus leptodactylus* (Licht.), belonging to the subfamily Sciurinae, family Sciuridae.

The Museum collection contains a second species of *Linognathoides*, also the gift of Mr. Rothschild, which stands very near the present species and was taken on *Marmota pruinosus*, Gmelin, a North American squirrel of the subfamily Sciurinae.

This second species is probably new, but is represented by only two poor specimens. The fact that they stand so near to the species about to be described affords strong presumptive evidence that the real host of *L. spermophili* is *Spermophilus* (or *Citellus*) and not the Murid *Cricetulus*. A reference to the published descriptions of species from squirrels, e.g., Piaget's *Haematopinus setosus* from *Xerus guttulus* and *Polyplax* (?) *montana* (Osborn) from *Sciurus cinereus*, makes it probable that at least a few of these will be found to fall very naturally into the new genus.

Linognathoides occupies a position midway between the genera *Linognathus* and *Polyplax*. The *Polyplax* characters are the strongly chitinised abdominal pleurites, which project on each side from the sides of the abdomen as blunt teeth, and the small size of the spiracles. The *Linognathus* characters are the large, soft abdomen without tergites or sternites, fat and much distended (so that it is difficult to clear with potash), and the long hairs which clothe it dorsally and ventrally. Other generic characters may be taken from the head, which widens suddenly behind the antennae, the sexual dimorphism present in the latter, and the terminal segment of the abdomen of the male, which is drawn out on each side (fig. 3) into a finger-shaped lobe, exactly as in Piaget's figure of *H. setosus*.

Linognathoides spermophili, sp. nov. (fig. 3).

External Form, Male.—Head: The first segment of the antennae is the broadest, and at its distal end on the upper surface is a minute, short denticle or "thorn." There is another denticle at the distal anterior angle of the third segment. The third segment differs from that of the female in that the distal anterior angle projects somewhat and the anterior lateral margin is consequently longer than the posterior. *Thorax* broadening posteriorly. No sternal plates visible. First pair of legs with the claw bifid at the tip; coxae of all three pairs widely separated, but those of the first pair nearer to each other than those of the other two pairs. *Abdomen:* The end of the abdomen is dorsally produced into a rectangular flap (fig. 3) formed by the tergite of the terminal segment. On each side of this flap the pleurae are produced into two finger-shaped processes, one on each side, converging inwards and meeting each other at the tip. On the ventral side a membrane stretches across between these two processes. From the base of each process a splint-like piece of chitin runs forward on the ventral surface to meet the genital plate, which is of the form shewn in the figure.

External Form, Female.—Head: The pre-antennal area is longer than it is in the male; the denticles are absent from the antennae, and the third segment of the latter is of the same form as the second. *Abdomen* as in the male, the sutures between the segments are difficult to see, and the tergites and sternites are absent. It is rather more swollen, soft and ovate than in the male. The pleurites do not differ in shape from those of the male (fig. 3). The gonopods are triangular, the apex of each triangle pointing inwards. Between the gonopods is a triangular genital plate, with the apex pointing backwards. In front of this plate is a second one, transverse in position and broader than long.

Chaetotaxy and Colouration, Male.—Head: On the margin of the pre-antennal area two small hairs, one on each side of the oral cone. A longer one on each side, a little further back; near the latter, but just inside the margin, another hair.

On the dorsal surface on the pre-antennal area, just behind the posterior margin of the transverse brown band, two small hairs in the middle, fairly close together. A little further back two more small hairs, widely separated. Behind the antennae two longer hairs one on each side, well within the lateral border near the ocular emargination. Two or three small hairs in the ocular emargination. Further back on the temporal wings, three hairs and one long bristle. In the middle of the dorsal surface of the post-antennal area, two minute hairs. On the ventral surface two small hairs one on each side of the rostrum. A hair of medium length on each side on the lateral margin of the head, just inside the posterior margin of the first segment of the antenna. *Thorax:* On the

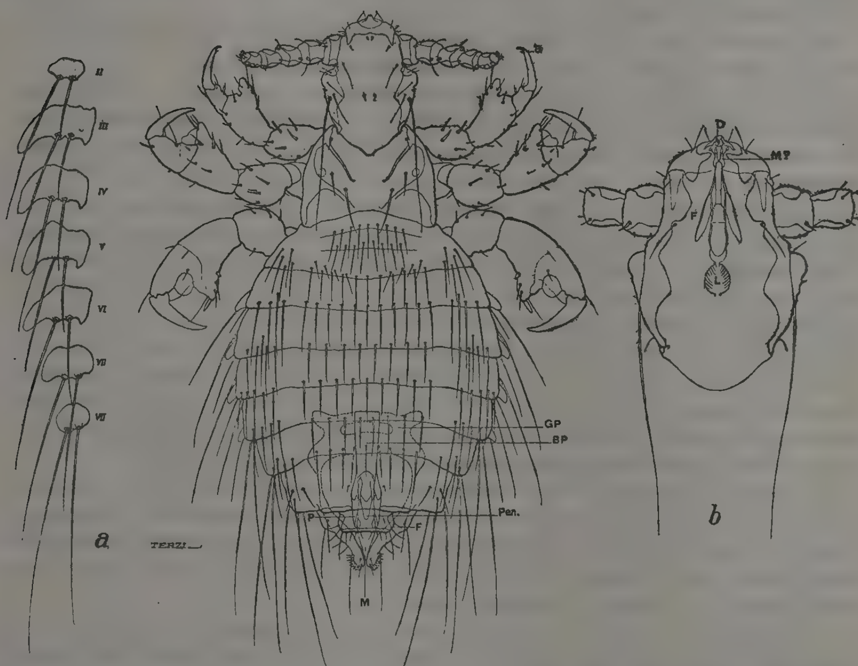

Fig. 3. *Linognathoides spermophili*, sp. nov., ♂: *a*, bifid claw; BP, basal plate; GP, genital plate; F, flap; M, mesosome; P, parameron; Pen., penis.—(*a*) Abdominal pleurites dissected off.—(*b*) Mouth-parts: D, rostral denticles; F, fultura; L, larynx; M (?), mandibles.

mesonotum just inside the spiracle, one short hair and one long bristle. *Abdomen:* On the dorsal surface, segment 1 with numerous hairs in the middle; segments 2 to 8 with a row of well-spaced hairs; segment 8 bare, excepting for two short hairs in the middle. The rectangular flap of the terminal segment possesses several hairs along the margin. Between the hairs above described occupying the mid-dorsal region and the hairs on the pleural area, there is in each segment a break or bare patch, which results in a longitudinal bare patch down each lateral part of the dorsal surface.

On the margin of each pleural plate are two long hairs (fig. 3*a*). On the dorsal side, in the pleural area of segment 2, is an irregular patch of short hairs; on segment 3 a row of three long hairs with a fourth behind; on segment 4 a row of four long hairs and one behind; on segment 5, of five long hairs; on segment 6, of four long hairs; on segment 7 there is a row of three long hairs and one behind; and on segment 8 three short hairs irregularly placed. The termination of each of the two finger-shaped processes at the end of the abdomen is armed with a number of strong recurved denticles. On the ventral surface there is a single row of hairs on each segment, excepting segment 8, which has only two hairs, one on each side of the basal plate. Further down are two more hairs, one on each side of the elongate mesosome of the copulatory apparatus.

On the head there are two brown "taches" in front of the antennae, one on each side, and there is a small brown mark in each ocular emargination.

Chaetotaxy, Female.—Abdomen with two longitudinal bare areas as in the male. Segment 9 is bare on the dorsal surface, except for four hairs on each side in a short transverse row, situated along the lower margin of the extreme lateral portions of the terminal dark band. On the ventral surface the hairs, as in the male, are less numerous than they are on the dorsal surface, and thinner, shorter and more widely spaced. They are arranged (somewhat irregularly) in two rows on each segment, excepting on segments 8 and 9, the former having a batch of minute hairs on the genital plate, and the latter with the hairs arranged on the gonopods and genital plate as described immediately below, i.e., there is a group of four hairs of medium length on the lower part of each gonopod and two smaller ones on the inside of these. Over the triangular genital plate there is a patch of 10 minute hairs arising from large alveoli. There is a powerful spine on each side of the genital opening, standing in a group of smaller hairs. A short longitudinal row of hairs runs from the base of each gonopod backwards, passing outside the spine to the margin.

On the dorsal surface of the last abdominal segment, a narrow band of dark-coloured chitin runs in a semi-circular fashion from one lateral margin to the other. The concave side of the band is posterior, and the two lateral ends on reaching the pleurae double back beneath to the ventral side, where they carry the large spine and group of hairs which guard the opening to the genital organs.

Mouth-parts.—Mandibles of the shape and in the position of those figured for *Haematopinus taurotragi* are absent. Enderlein (7) in his description of the mouth-parts of *Pediculus vestimenti* regards the lateral "taches" as containing the vestigial remains of the mandibles, which are so well developed apparently throughout the genus *Haematopinus*. These "taches," however, appear to be no more than coloured and strongly chitinised supports for the sides of the proboscis, and resemble similar chitinous thickenings on the ocular emarginations and on the temples and elsewhere. I have tentatively suggested in fig 3 *b*, that the two small pieces one on each side of the oesophagus in front may be homologous with the mandibles. The larynx is quite characteristic of this species, being transversely furrowed and roughly heart-shaped.

*Male Copulatory Apparatus**—The paramera are so closely applied to the mesosome

* The terminology adopted in this and other descriptions of the copulatory apparatus of the male is that suggested by the Rev. James Waterston (8).

as to be scarcely distinguishable from it. The endomera are fused and drawn out into a structure shaped like the head of a spear with serrate lateral margins. The penis is present. The basal plate is long and parallel-sided.

Measurements of LINOGNATHOIDES SPERMOPHILI *in millimetres.*

	♂		♀	
	Length.	Breadth.	Length.	Breadth.
Head	·32	·28	·43	·335
Thorax	·27	·41	·365	·546
Abdomen..	·78	·62	1·3	·95
Total	1·37	1·31	2·095	1·831

	♂			♀		
Length of legs	1st	2nd	3rd	1st	2nd	3rd
Femur	·11	·083	·083	·116	·11	·096
Tibia + tarsus	·14	·183	·183	·17	·24	·266
Claw	·053	·1	·1	·085	·096	·12
Total	·403	·366	·366	·371	·446	·482

Length of Segments of Antenna.	♂	♀
1	·05	·07
2	·06	·07
3	·06	·06
4	·04	·04
5	·03	·05
Total	·24	·29

Colpocephalum mjöbergi, sp. nov. (figs. 4, 5, 6).

The species of *Colpocephalum* here described was taken on a species of crested guineafowl, *Guttera cristata*, Pallas, in the Budongo Forest, Unyoro, Uganda, on 14th December 1911, being part of material submitted for determination and kindly presented to the Museum by the Imperial Bureau of Entomology.

External Form, Male (fig. 4).—*Head:* The eye is prominent and the cornea apparently consists of two lenses connected by a neck. The black pigment of the eye is broad at the base, the distal half being conical, the cone running out to touch the cornea at the neck between the two lenses. The antennae have the third segment pedunculate and the fourth broad, columnar and parallel-sided. *Thorax:* The prosternite is small, oval. The endoskeleton is worth remark. The "clavicles" are strong bars running upwards and forwards from each side of the prosternite

to be inserted into the rounded anterior corner, just above the angle made by the transverse band where it enters the longitudinal band on each side. The upper end of each clavicle is a little swollen and shows as a minute colourless circle upon the dorsal integument, suggesting that this may be an atrophied spiracle and the clavicle itself a tracheal tube metamorphosed into a chitinous support. *Legs:* First pair: the coxae lie longitudinally and are in shape something like a propeller-blade; posterior margin of the femur very convex. Second pair: coxa in the form of a truncated cone; femur less powerful. In all three pairs of legs at the distal extremity of the

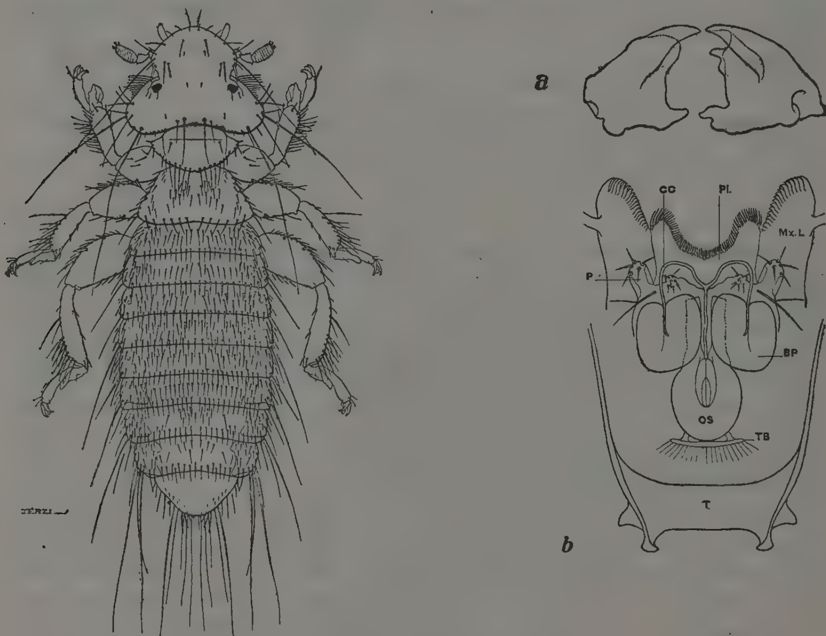

Fig. 4. *Colpocephalum mjöbergi*, sp. nov., ♂.

(*a*) Mandibles.—(*b*) Mouth-parts, with the mandibles removed: BP, basal piece; CC, chitinous chords; Mx.L, maxillary lobe; OS, oesophageal sclerite; P, labial palpus; Pl., fringed plate; T, tentorium; TB, transverse bar, with muscle strands attached.

tarsus, projecting between the two claws, in the position usually occupied by the pulvillus in Diptera, are two minute delicate organs (fig. 5, Pv.). Only one on each tarsus is shown in the illustration. These small pulvillus-like structures occur in *Menopon* and other genera and are perhaps of general occurrence in the Mallophaga. Kellogg and Nakayama (9) have recently described them in their new genus *Philandesia*. If they really prove to be homologous with the pulvillus, the Mallophagan onychium must be something *sui generis*. *Abdomen:* The figure (fig. 4) gives an excellent idea of the shape.

External Form, Female (fig. 5).—*Abdomen:* The genital plate is triangular, with the apex pointing backwards. There is another plate of indistinct outline in front of it and covered with a dense cluster of hairs. On each side of the genital plate a

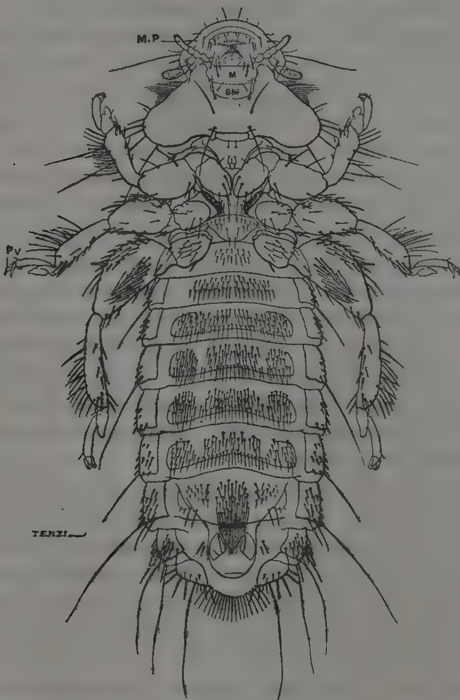

Fig. 5. ***Colpocephalum mjöbergi*, sp. nov., ♀, underside: M, mentum; MP, maxillary palpus; Pv, pulvillus; SM, submentum.**

small somewhat triangular plate is situated, of rather uncertain outline. The whole abdomen is broader than that of the male and less graduated in width towards the tip, which is quite as wide as the base.

Chaetotaxy, Male (fig. 4).—*Head:* On the anterior margin two fairly long hairs, widely separated; two shorter ones, one on each side, further back. On the prominence in front of the ocular emargination are situated one long bristle, two shorter spiny ones behind it, and one in front of it. At about the same level, only inside the margin, on the dorsal surface, two hairs of medium length, close together. On the margin at the base of the clypeal area and at about the level of the mandibles, a fairly long hair on each side. A short hair over the eye. A strong ocular fringe is present, the anterior hairs being the longest. On the temples, on each side, two very elongate hairs and two or three shorter ones. Along the occipital line, four hairs of medium length, overhanging the pronotum. Further out, near the temporal

angles, two widely-spaced minute hairs. On the ventral surface, two longitudinal rows of hairs, four or five in each row, running from the submentum to the occiput. On the premandibular cushion there are 12 spines on the anterior margin, the outside ones being the longest, and 16 smaller ones, more closely spaced but with larger alveoli, on the posterior margin. Just behind the posterior margin of the cushion and near the tips of the mandibles are two small denticles, each of them bifid. *Thorax :* Anterior margin of pronotum with a small hair, just outside the occipital hole. The angles of the lateral wings each with two short spines, one below the other; two more behind, one below the other. The posterior margin of the pronotum with a row of well-spaced hairs of medium length. Just inside the wing, at each end of the transverse line, a small hair. Lateral margins of the metanotum with many short hairs. Other hairs arranged as in the figure. The legs are noticeable for a patch of thick hairs on the lower surface of the hind femur. *Abdomen :* Tergites each with two irregular rows of well-spaced hairs of medium length, except the ninth, which is bare. Pleurae with longer hairs, one being, as a rule, much longer than the rest. Pleurae of segment 8 with two long hairs. The lateral margins of the terminal segment with six hairs on each side, the last one being very long; the apical margin with eight or nine smaller hairs. Sternites 3 to 7 with a patch of short hairs crowded together on each side of the middle line, well within the lateral margin. Sternites 2 and 3 with a number of fairly small, irregularly arranged hairs, present also on the other sternites, between the right and left patches. Lower lip of the opening to the genital chamber with numerous long bristles.

Chaetotaxy, Female (fig. 5).—*Abdomen :* Tergites bare except those of segments 8 and 9, on the former of which there is a row of hairs on the posterior margin, and on the latter, numerous small somewhat scattered hairs arranged in an irregular row. Sternites as in the male. Genital plate bare, but covered by the cluster of hairs which are situated on the plate in front of it. Integument dorsally and ventrally covered with an immense number of minute denticles, like the skin of a dogfish. Pleurae with many short spines. Pleurae of segments 2, 4, 6 and 7 each with a single long hair, 8 with two long hairs. Terminal margin of the abdomen with four powerful spines on each side and one long hair on the inside of these; between these two longer hairs are numerous less powerful spines. Lip of the opening to the genital chamber closely set with numerous spiny hairs.

Colouration.—Both sexes are white above; eyes black. On the ventral surface the male has the sternites of the thorax dark brown or black. The abdominal sternites also show in most specimens an irregular, dark brown patch on each side. The ventral surface of the female is coloured as follows:—Tips of mandibles black; two black marks on each side of the occiput; prosternite brown, lateral bands in the mesosternal region black; abdominal pleurae each with a heavy, dark brown, longitudinal band; each sternite banded transversely with brown, paler in the middle.

Mouth-parts (fig. 4, *a*, *b*).—*Labium :* The submentum is a well-marked broad rectangular plate. The mentum carries two small lobes, usually called paraglossae. Between these are two slight projections carrying several small hairs. *Isopogometric apparatus* :* The anterior cornua of the oesophageal sclerite (or lyriform organ),

* See E. Armenante (10).

are rather long and truncate at the tips. There are no posterior cornua, but, at the posterior end of the sclerite, is a transverse chitinous bar (fig. 4, *b*, TB) which projects on each side, each free end being buttressed against the oesophageal sclerite by a small piece which runs forward and somewhat downwards, as the bar is not only posterior to the sclerite, but also dorsal. Numerous muscle fibres are attached to the transverse bar. The two basal pieces (or lingual "glands") are parallel-sided, with truncate anterior and posterior ends. The chitinous chord (or "duct") bifurcates far forward, where each ramus or branch curves round and runs backward to enter the basal piece. The descending and ascending chords are parallel to each other. In front, at the point of bifurcation, the chords bear a delicate plate, the dentate anterior edge of which projects from the mouth. *First maxillae:* The palpus is fairly long. The first segment is wider distally than proximally, the two middle segments about equal in size, and the terminal segment longest and columnar. The lobe is rather elongate and narrow. In front, it is, as usual, armed with a patch of minute hook-shaped denticles. The lobe is thinly chitinised, except on the outer margin behind the patch of hooks, where there is a thickening, for a muscle attachment. *Mandibles* as usual. In optical section a series of deep, longitudinal grooves are seen to be present. *Cushion* much broader than long, considerably shorter than the cushion of the Goniodidae. It is convex in front, and slightly concave behind, the thickened margin being continuous all the way around. In the Goniodidae it ceases at the base on each side and the lower margin is therefore separate, at each end supported by a narrow longitudinal sclerite which runs backward beneath the mandibles. *Tentorium:* I have ventured to homologise with the tentorium a structure of the head, which I do not think has hitherto been described in Mallophaga. This is a broad band-like transverse plate situated in the gular region just below the integument. The posterior lateral angles project backwards in a well marked process (fig. 4, *b*, T). At each side the band curves upwards to the roof of the skull. The perpendicular walls thus formed run forward towards the mouth-parts, joining up with the thick chitin which forms the point of articulation to the mandibles.

Alimentary Canal (fig. 6, *a*).—This is of the same general type, which distinguishes the Amblycera, but the crop, or ingluvies, is unusually large and without anterior diverticula. Its large size and perfect oval shape recalls the crop in the Ischnocera. The lining is covered with very minute hairs, and around the lower end of the crop is the usual row of teeth (10) or ingluvial comb (fig. 6, *a*, CT). Each tooth is a flat sabre-like blade, serrate along one edge. The ventriculus, in the specimens examined (which were not very well preserved for the study of the soft parts), is a somewhat broad tube without anterior diverticula and connected with the crop by no very marked constriction. The rectum is large and globular, or bowl-shaped. The six glandular patches are rectangular with rounded angles.

Male Reproductive Organs (fig. 6, *c*).—As usual in the Amblycera, there are six testes, three on each side, pear-shaped and sessile on the vas deferens. The vesicula seminalis bears a curious resemblance to the Ctenophor, *Hormiphora* (fig. 6, *c*, VS). The originally double character of this organ is still indicated by a fine line (or furrow) which runs up through the aboral or anterior end. Two accessory glands are present, one on each side of the base of the vesicula seminalis. They are attached lower down and nearer the upper end of the ductus ejaculatorius than an examination of

the figure might lead one to suppose. Accompanying the ductus from the seminal vesicle towards the preputial sac are two enigmatic structures, one on each side. The preputial sac is large when expanded, its surface covered with minute recurved denticles.

Male Copulatory Apparatus (fig. 6, *b*).—The basal plate is elongate, the strongly chitinised lateral margins curving in towards each other. The paramera are long and curve gracefully outwards at the tip. The articulation of the paramera with the

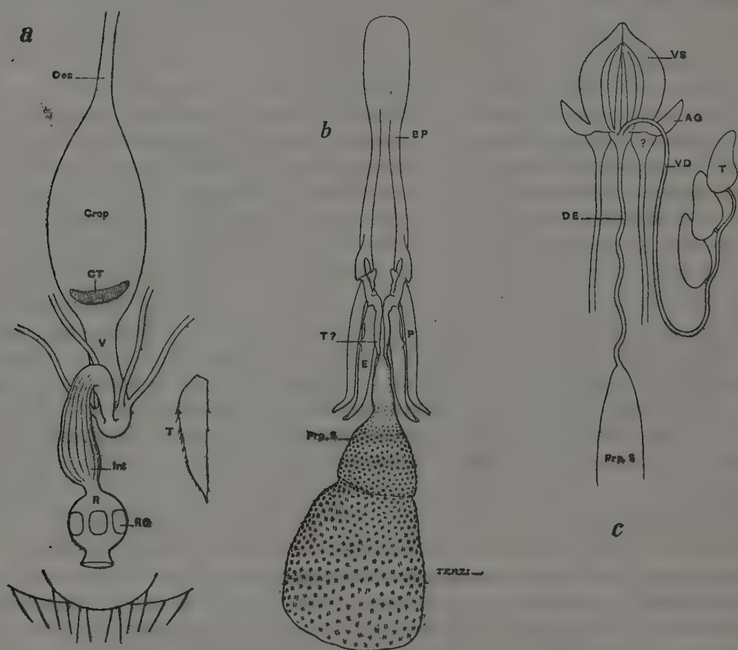

Fig. 6. *Colpocephalum mjöbergi*, sp. nov.

(*a*) Alimentary canal of ♀; Oes., oesophagus; CT, crop teeth; V, ventriculus; Int. intestine; R, rectum; RG, rectal glands; T, one of the crop teeth highly magnified.—(*b*) Male copulatory apparatus: BP, basal plate; E, endomeron; P, parameron; T, ? telomeron; Prp. S, preputial sac.—(*c*) Internal genital organs of ♂: VS, vesicula seminalis; AG, accessory gland; VD, vas deferens; T, testis; DE, ductus ejaculatorius; Prp. S, preputial sac.

basal plate is somewhat complex (fig. 6, *b*, P). Each of the side-pieces (or lateral margins) of the basal-plate sends forward beneath the articulation of each parameron a narrower piece which, meeting its fellow in the middle line, runs forward with it without fusing to the base of the preputial sac, a deep groove lying between them; they perhaps represent the telomera. Distally they fade away into the membrane of the sac. The endomera are well developed, resembling the paramera in form, and are articulated below the latter to the basal plate.

Measurements of Colpocephalum mjöbergi *in millimetres.*

	♂ Length.	♂ Breadth.	♀ Length.	♀ Breadth.
Head	·4	·64	·41	·72
Prothorax	·22	·47	·24	·528
Metathorax	·21	·51	·27	·68
Abdomen..	1·35	·67	1·56	·85
Total	2·18		2·48	

Length of legs.	♂ 1st pair.	♂ 2nd pair.	♂ 3rd pair.	♀ 1st pair.	♀ 2nd pair.	♀ 3rd pair.
Femur	·21	·21	·34	·24	·25	·28
Tibia	·17	·2	·27	·21	·21	·27
Tarsus + claws..	·18	·2	·21	·16	·18	·20
Total	·56	·61	·82	·61	·64	·75

Length of Segments of Antenna and Palpus of the 1st Maxilla.	♂ Antenna.	♂ Palpus.	♀ Antenna.	♀ Palpus.
1	·0$\dot{3}$	·03	·0$\dot{3}$	·0$\dot{3}$
2	·04	·026	·04	·0$\dot{3}$
3	·0$\dot{3}$	·03	·05	·03
4	·0$\dot{6}$	·06	·08$\dot{3}$	·06
Total	·17$\dot{3}$	·146	·20$\dot{6}$	·15$\dot{9}$

Menopon robsoni, sp. nov. (fig. 7).

This remarkable louse, named after Mr. G. C. Robson, of the Zoological Department of the British Museum, was brought back by the Wollaston Expedition to Dutch New Guinea, 1913. The label on the tube endorsed "C. B. K." (C. Boden Kloss) conveyed the information that its contents, including 2 females of the new *Menopon*, several specimens of *Nirmus varius* and a single Corvine *Dochophorus*, were taken at Launch Camp, Setakwa River, on 13th March 1913, on the "Hawk Crow." Mr. A. F. R. Wollaston kindly tells me that I should be probably correct in referring this to *Gymnocorax senex* (Corvidae).

M. robsoni belongs to the general type of Carriker's *Colpocephalum extraneum* from the nightjar, *Nyctidromus albicollis* (Costa Rica) (11) and also of Kellogg's *Colpocephalum sjöstedti* from *Corvus scapulatus* and *Corvultur albicollis* (Africa) (12), characterised by the development of pro- meso- and meta-thorax into separate thoracic elements (as in *Trinoton*). There can be no doubt that these two species, together with the new *M. robsoni*, which are all closely related, form the nucleus of a new genus of Mallophaga, with members of the Corvidae as hosts.

The genus, *Colpocephalum,* is in the present state of our knowledge, often difficult to separate from *Menopon.* The new species is, however, placed in *Menopon,* rather than in *Colpocephalum,* on account of the characteristic Menopoid roofing over of the ocular emargination.

I have been unable to refer to Carriker's description of *C. extraneum* but am satisfied from Kellogg's references to it that *M. robsoni* is a different species. To *C. sjöstedti* the new species stands very close. Fortunately, the British Museum possesses a single female specimen of *C. sjöstedti* identified by Prof. Kellogg, and by the aid of this and his figure and description it has been possible to signal the differences. It was sometimes difficult to make the figure agree with the description, and the specimen of *C. sjöstedti* is unfortunately a poor mount. But according to the figure and the specimen the mesonotum of that species runs out straight into a pointed posterior angle. In *M. robsoni* the outline at the sides of the mesonotum is convex. In the abdomen, segments 2 to 6 in *C. sjöstedti* have many short spines on the lateral margins, segments 7 to the last each having two elongate hairs in the same position. In *M. robsoni* segment 2 also has two elongate hairs. The pleural plates are quite different in form in the two species ; there are no median plates in *M. robsoni,* and in *C. sjöstedti* on the dorsal surface just inside the pleural region of the abdomen on each of the segments 2, 3, 4, 6 and 8 there is on each side a single elongate bristle which is absent in *M. robsoni.* Another very considerable difference between the two species is to be found in the sternites of the thorax, which are different in form (particularly the metasternum), and the chaetotaxy is on an entirely different plan.

External Form, Female.—General conformation peculiar. The thorax dorso-ventrally is deep and antero-posteriorly very long. The abdomen is very short and decreases rapidly in depth from the base to the apex. *Head :* The figure gives an accurate idea of the shape of the head, and a reference to it (fig. 7) and to the figure of the antenna (fig. 7, *b*) makes further details superfluous. *Thorax :* Wings of pronotum rectangular. Posterior margin convex on the mesonotum and rounded. Prosternite like a bow and arrow, the tip of the arrow pointing to the rear and projecting slightly beyond the convex margin of the plate, this margin being semicircular and representing the bow. The anterior part of the prosternite, representing the posterior part of the arrow, instead of being narrow is broad. The clavicles run down from the anterior shoulders to join the posterior part of the prosternite. The mesosternite is a powerful sclerite, densely chitinous and roughly quadrilateral. The four angles each with a chitinous ray. The two anterior rays are long, run outwards transversely on each side to the lateral margin and, joining the mesonotum, coil around the base of the coxa of the second pair of legs so as to form an acebabulun. The front margin of the plate is slightly convex. The hind margin is straight. The metanotum is produced on each side into two large shoulders. The metasternite is the largest of the three sternal plates; it is dagger-shaped with three acute angles anteriorly, one on each side and one in front. *Legs :* Coxae of first pair lying just below the prosternite and in front of the anterior bars of the mesosternite. They are nearer to each other than the other two pairs of coxae, and also longer. *Abdomen :* Nine segments, with traces of a tenth on the ventral side at the base. Spiracles minute, only 5 visible. Segments 8 and 9 longer than the others. Basal segments short, with the suggestion of being somewhat telescoped towards the metathorax.

Pleurites with an oblique whitish line dorsally in segments 3, 4, 5 and 6. Ventrally, segment 1 has a short, broad sternite, divided by a median line into two separate plates. Segment 2 with a sternite longer than any except those of 8 and 9. On segments 3, 4, 5, 6 and 7 there are no median sternal plates; that of 8 is large and semicircular.

Chaetotaxy, Female.—Head: Two straight hairs close together on the clypeal margin in front. On the margin, in front of the spot where the tip of the maxillary palpus projects, 3 more hairs. Two hairs above the tip of the palpus. Two very long hairs and two shorter ones on the margin before the antennae. The ocular

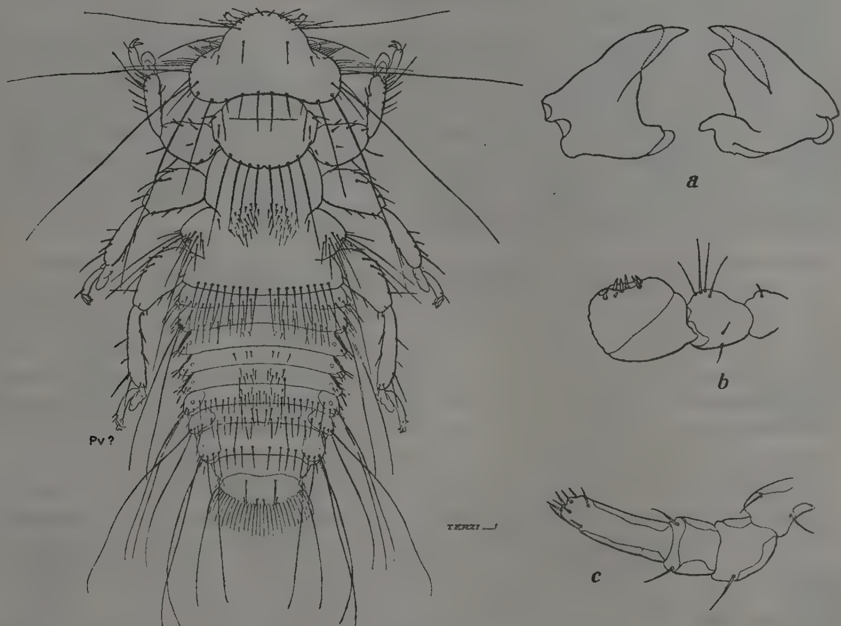

Fig. 7. *Menopon robsoni*, sp. nov., ♀: Pv., ? pulvillus; (*a*) mandibles; (*b*) antenna; (*c*) maxillary palpus.

fringe consisting of about 8 or 9 hairs. Temples with 4 very long hairs, not set in very large alveoli. Along the occipital line two long hairs in the middle, and two shorter ones on each side of this pair further out. A hair on each side on the dorsal surface near the base of the antenna. *Thorax:* Wings of pronotum with two short spines in front; a third further back well inside the margin. Prosternite with 2 hairs in front. Convex posterior margin of the pronotum with 6 or 7 fairly long hairs. Mesonotum probably bare. Mesosternite with a row of 4 small widely-spaced hairs. Shoulders of metanotum with 3 elongate hairs and about a dozen shorter ones of varying lengths. Hind margin with a row of moderately long hairs. In the middle of the metanotum two patches of small hairs. Posterior half of the

meta sternite crowded with hairs of medium length. *Abdomen:* Chaetotaxy a little uncertain owing to lack of material. Tergites with a few minute hairs on the posterior margin; these are longer on segments 6, 7 and 8. Pleurae of segment 1 with a bunch of small spiny hairs on the ventral surface; those of the other pleurae with smaller and fewer spines in the same position. Pleurite of segment 2 with two long hairs, one very much longer than the other. Pleurites of segments 3, 4 and 5 with only minute spines, of segments 6, 7, 8 and 9 with two very elongate hairs. On the sternite of segment 1 in each anterior outside corner two straight bristles directed forwards. Sternites 3, 4, 5, 6 and 7 with a patch of small hairs on each side. Sternite 8 with a number of minute scattered hairs over its broad surface. Sternite 9 with a transverse row of rather small hairs.

Mouth-parts.—Mandibles: Inner condyle well developed, in the form of a rounded knob (fig. 7, *a*). *Maxillary palpus* (fig. 7, *b*): This appendage curves outwards laterally from the mouth-parts to the side of the head, beyond which it projects slightly. This position is brought about by the form of the two basal segments. *Isopogometric apparatus:* Anterior cornua of oesophageal sclerite with truncate tips. Two posterior projections present. The plate carries a fringe of delicate teeth. The basal pieces are parallel-sided, truncate in front and behind.

Measurements of MENOPON ROBSONI, ♀, *in millimetres.*

	Length.	Breadth.
Head	·31	·56
Prothorax	·21	·38
Rest of Thorax	·52	·7
Abdomen	·75 or ·65*	·64
Total	1·79 or 1·69	2·28

Length of legs.	1st	2nd	3rd
Femur	·183	·21	·25
Tibia	·166	·22	·24
Tarsus + claw	·106	·14	·14
Total	·455	·57	·63

Length of Segments of Antenna and Palpus of the 1st Maxilla.	Antenna.	Palpus.
1	·018	·118
2	·004	
3	·030	
4	·048	
Total	·1	·118

* According as one reckons from the real base of the first segment or from the edge of the meta-thoracic overlap.

Goniocotes waterstoni, sp. nov. (fig. 8).

The specimens on which this description is based were presented to the British Museum in 1913 by the Hon. N. C. Rothschild and were collected by R. N. Atkinson in November 1912, on the penguin, *Eudyptula minor*, in the Furneaux Islands.

G. waterstoni stands nearest to *G. bifasciatus*, Piaget (3, p. 47), from *Spheniscus demersus*, with which, through the kindness of the Rev. James Waterston, I have been able to compare it. The present species differs in its shorter head, in the form of the male genitalia, and its antennae.

External Form, Male.—Head: Preantennary margin perfectly rounded. Antennary sinus large, roofed in dorsally by transparent chitin. Its posterior corner is produced forwards into an angle with several small hairs on it. Immediately behind this angular projection at the side of the head is the eye, which carries a short spine. Antenna almost four-segmented, as the fifth segment is very small and partly fused with the fourth. The first segment is the largest, equal in length to half the length of the whole antenna, swollen. Temples with two angles, the rounded anterior one carried outwards so as to make the post-antennal area of the head almost as broad as the abdomen. The posterior angles are produced backwards on either side of the occiput so as to embrace the prothorax (fig. 8 *a*). The two occipital apodemes tapering and slightly convergent. *Thorax:* The prothorax is broad and short, the hind margin of the pronotum convex on the metanotum. The endo-skeleton shows, as usual, the two clavicles running upwards and forwards from the prosternal region to the anterior lateral corners. The upper part of each clavicle is slender and narrow, the lower part broadening out. The main difference between the prothoracic endo-skeleton and that in the other species here described is that the clavicles do not descend very appreciably from the anterior corner of the pronotum towards the prosternum but abut against, without actually fusing with, two small rectangular plates lying within the rear part of the prothorax. These two small plates lie above and are apparently connected with two larger plates of irregular outline, representing perhaps the prosternite. These extend below the hind margin of the prosternum and their ends lie between the coxae of the second pair of legs; each receives the inner end of two deep brown strongly chitinised bands or septa which run in along the ventral side between the pro- and meso-metathorax from the sides. Metathorax broader than the prothorax, each side running out into a projection. *Abdomen:* Segments 8, spiracles 6. Pleurites with their internal free ends rounded. First pleurite narrower from left to right than the others, the external "beak" being very small and partly fused with the next pleurite. Terminal segment extremely convex (as usual in GONIODIDAE). The genital chamber opens by a semicircular slit upon the dorsal surface.

External Form, Female.—Head: Antennary sinus not so large, its anterior and posterior angles being less pronounced. Antennae small. Segment 1 the largest, but much smaller than segment 1 in the ♂. Segment 5 more developed than it is in the ♂. *Abdomen:* Pleurites with the free internal ends truncate; terminal segment narrowest, rounded behind, but not convex as in the ♂. Genital opening on the lower side of the segment, situated far forward and in the form of a semicircle with its concavity behind. The actual slit is directed backwards and lies

between dorsal and ventral lips, whereas in the male the slit is directed dorsally and the lips are anterior and posterior.

Chaetotaxy, Male.—Head: Anterior margin with numerous small minute hairs. Dorsal surface with many scattered minute denticles or short spiny hairs. At the anterior lateral angle, one long bristle, succeeded from behind forwards by a very short one, then a longer one and then another shorter one. Posterior lateral angle with one long bristle. *Thorax:* Along hind margin of pronotum two long hairs, one on each side. Lateral angles of metanotum with two or three long bristles and three or four short spines. Hind margin of metanotum with a row of bristles, the two outside ones being very long and reaching to the fourth abdominal segment. *Abdomen:* Many fairly long hairs on the dorsal surface occupying the median area. Pleurites bare, except at the external angles, where there are two fairly long bristles, and except for the hind margin of the last pleurite, which has a row of three or four long bristles. Two bristles on the dorsal surface of the last segment arising just over the base of each parameron, one on each side. On the ventral surface there is a single row of rather fine hairs on each of the first six segments. The first row lies between the hind coxae and consists of only four hairs. The sixth row is very convex, starting on each side on segment 6 and curving forward on to segment 5. Convex terminal margin of last segment with numerous long bristles.

Chaetotaxy, Female.—Head: Anterior lateral angles of the post-antennal area each with a small spine-like hair and three other spines still more minute. *Abdomen:* Hind margin of last segment with six long hairs, three on each side. The lower lip of the genital opening with the sides drawn out into a gonopod-like form, bearing numerous short hairs, which are however longer than the hairs along the central part of the lip.

Mouth-parts (fig. 8, *b*).—*Mandibles:* As usual, very powerful and densely chitinous; articulation complex. *First maxillae* consisting of a single pair of lobes, one on each side of the mouth, without palpi. As in *Goniodes tetraonis* (13) and in some others, these lobes are thin, flattened and atrophied, lying inside the mouth. In this species the lobes are bare of hairs, setae or hooks. *Second maxillae:* On the labium are the following structures :—(*a*) two relatively large columnar lobes with terminal spines, usually called paraglossae ; (*b*) between the paraglossae six hairs, three on each side, the two outside ones on each side carried each on a minute prominence ; (*c*) at the base of each paraglossa, lower down on the labium, a minute lobe, well chitinised, angular, bare, previously described by Shipley (13) in *G. tetraonis*. The paraglossae perhaps represent the labial palpi and the minute lobes (8*b*, OL) the outer lobes. *Oesophageal sclerite:* The anterior cornu short and concave on the inner margin. *Cushion*, as usual in the GONIODIDAE, well developed. A round "blob" of dark chitin is situated in the middle of its anterior margin.

Male Copulatory Apparatus.—The figure (fig. 8 *c*) makes it possible to dispense with a great deal of description. The parts are rather complex and closely fitting. The lateral margins alone of the basal plate are strongly chitinised. The paramera are short and broad, broader at the distal than at the proximal end. The endomera lie next within the paramera and, though free distally, are fused with one another higher up ; but still higher up they become free again, the free ends being conspicu-

ously situated on each side immediately on the inside of the lower part of the lateral margin of the basal plate. Within the endomera is a large, somewhat globular piece, probably consisting of the fused telomera. Distally and ventrally it is drawn out into two sharp processes separated by a deep incision. There is apparently no penis.

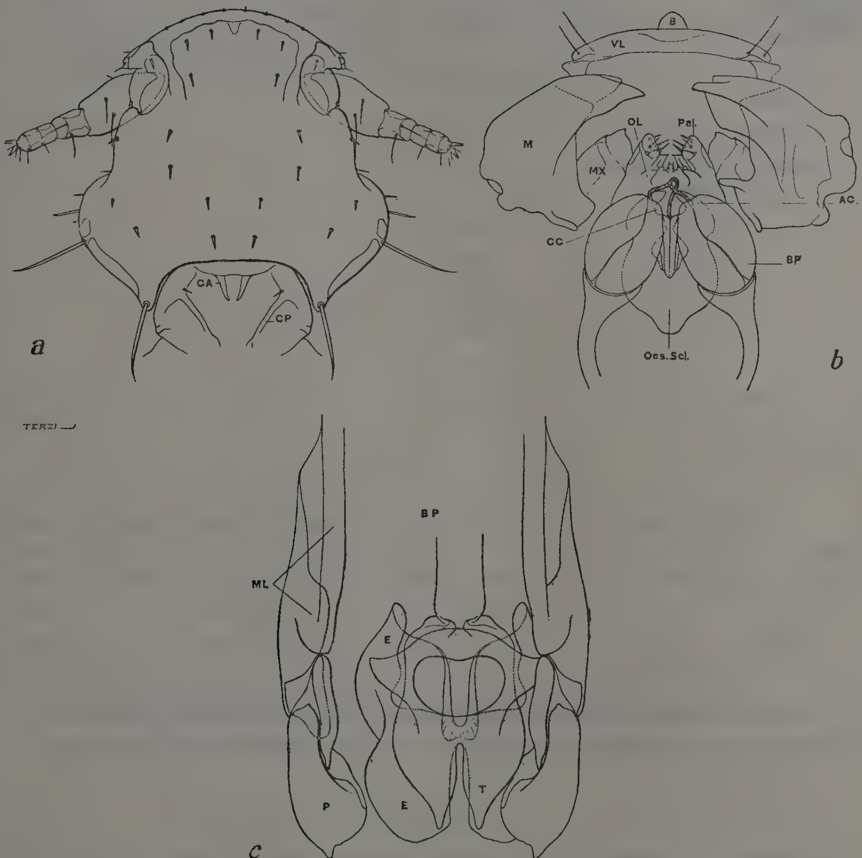

Fig. 8. *Goniocotes waterstoni*, sp. nov.

(*a*) Head and prothorax of ♂ : CA, cephalic apodeme ; CP, clavicle.—(*b*) Mouth-parts : B, tab ; VL, upper lip ; M, mandible ; MX, maxillary lobe ; OL, outer lobe of 2nd maxilla ; Pal., labial palpus ; AC, anterior cornu of oesophageal sclerite ; CC, chitinous chord ; BP, basal piece ; Oes. Scl., oesophageal sclerite.—(*c*) Male copulatory apparatus : BP, basal plate ; ML, lateral margin of basal plate ; E, endomeron ; P, parameron ; T, telomeron.

Measurements of GONIOCOTES WATERSTONI *in millimetres.*

	♂ Length.	♂ Breadth.	♀ Length.	♀ Breadth.
Head	·37	·52	·41	·55
Prothorax	·12	·28	·114	·27
Metathorax	·15	·428	·15	·428
Abdomen..	·77	·71	·77	·67
Total	1·41		1·444	

Length of Segments of Antenna.	♂	♀
1	·03̇	·05
2	·046	·03̇
3	·02	·023
4	·016	·02
5	·016	·02
Total	·131	·146

Length of legs.	♂ 1st	♂ 2nd	♂ 3rd	♀ 1st	♀ 2nd	♀ 3rd
Femur	·12	·13̇	·14	·114	·114	·128
Tibia + tarsus + claw	·156	·16̇	·17	·03̇	·03̇	·128
Total	·276	·29̇	·31	·147	·147	·256

I have to thank the Rev. James Waterston, B.D., B.Sc., of the Imperial Bureau of Entomology, for much kind assistance during the preparation of this paper.

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NOTES ON PHLEBOTOMUS, WITH DESCRIPTIONS OF NEW SPECIES.

Part II.

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In this paper four new species of *Phlebotomus* are described, three from Africa and one from the Malay States, and the differential characters and affinities of seven other known species are described and illustrated. Three specimens, including one of *P. minutus*, Rond., and two of *P. papatasii* (Scop.), have been observed to possess supernumerary spines on the superior claspers: a remarkable and apparently hitherto unrecorded phenomenon in this genus. In several instances fresh data are given as to the geographical distribution of these insects, and an endeavour has been made to clear up some confusion with regard to certain closely allied species.

The major portion of the material has been supplied by the Imperial Bureau of Entomology, through the Director, Mr. Guy A. K. Marshall, to whom I express my grateful thanks. I beg also to acknowledge my indebtedness to Drs. E. Sergent and E. Roubaud, of the Pasteur Institute, Paris; to Captain Marett and Drs. M. H. Babington, A. Ingram, A. T. Stanton and F. D. Walker, and Mr. G. Bedford for the interesting material which they have been pleased to submit to me from time to time.

As our studies of these minute and obscure insects has advanced, the more difficult and serious have the problems concerning the exact elucidation of the specific taxonomic characters become. This is due in a large measure to the apparently great range of variation which exists in the antennal and palpal formulae, and also the wing venation; more especially so is this the case in that group of which *P. minutus* may be taken as a type. Pairs taken in coitu are much needed for microscopical study, as at present the females, at least, are distinguishable only with great difficulty and minute examination.

To the student of this group of insects I would venture to call attention to the inexpediency of relying solely on one set of characters, such as the antennae, the palpi or the wings; and in some instances the male genital armature also. All the factors must be taken into consideration by the systematist. I would appeal also to those who deal with the taxonomy of these small midges to supplement their papers with carefully prepared drawings, as in the absence of these it is often impossible to determine a species with accuracy.

Phlebotomus ingrami, sp. nov. (fig. 1).

♂.—Length, 2·2 mm; wing, 1·5 mm; front leg, 2·2 mm; hind leg, 2·8 mm.

A relatively small species, the distinguishing features of which are the densely packed group of long stiff bristles at the end of the inferior claspers and the two pairs of widely separated spines on the superior claspers.

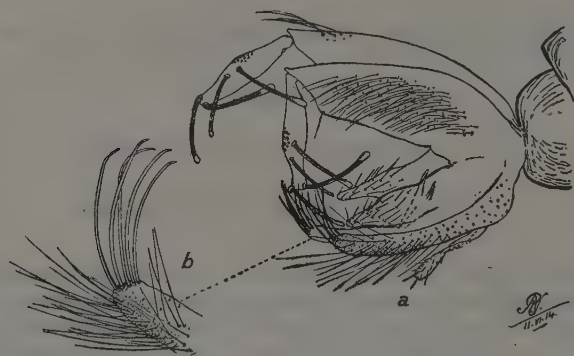

Fig. 1. *Phlebotomus ingrami*, sp.n., ♂; *a*, genital armature, × 150; *b*, distal portion of inferior clasper, × 225.

Antennae composed of *long slender segments* similar to those of *P. simillimus*, but the third segment is relatively shorter and barely reaches to the tip of the proboscis. Palpi relatively stout, 2nd segment about half the length of the fourth. Wings narrowly lanceolate; tip of 1st longitudinal vein overlapping the anterior branch of the second vein by a little more than one-third its total length. *Legs* densely clothed with narrowly lanceolate scales; ungues simple and near them, on the tarsus, three pairs of spines, the ventral pair minute; the subventral pair about half the length of the lateral ones. External genital armature (fig. 1, *a*) relatively small compared with the width of the abdomen; terminal segment of the superior claspers with two pairs of widely separated spathuliform spines; inferior claspers (fig. 1, *b*) with a densely packed group of long stiff bristles; there are 5 of these on one of the appendages and 7 or 8 on the other, possibly one or more may have been broken away from the former in preparing the specimen for microscopical examination.

I cannot unfortunately give any details regarding the general arrangement of the hairs on the body, as the specimens were mounted in Canada balsam before they were seen to differ in any marked degree from *P. minutus* var. *africanus*, Newst., with which they were associated. I have pleasure in dedicating this very distinct species to its discoverer.

Northern Ashanti: Kintampo, ♂ (type), in latrine, vii. 1913; Banda, 1 ♂, in rest house, 24. ix. 13 (*Dr. A. Ingram*).

Phlebotomus simillimus, sp. nov. (fig. 2).

♂.—Length, 2·6–2·7 mm; wing, 1·5–1·6 mm. ♀.—Length, 2·6–2·8 mm; wing, 1·8 mm.

Very like *P. minutus* var. *africanus*, Newst., but both sexes may be distinguished at once by the great length of the 3rd segment of the antennae, which, in the ♂, is twice the length of the proboscis proper (*i.e.*, exclusive of the clypeus), the distal portion of which projects beyond the tip of the latter. The wings in both sexes are broader than they are in *africanus*, and less pointed, the tip of the first longitudinal vein also extends much further forward, overlapping the anterior branch of the second vein by about half its length ; generally both sexes are also much larger and the females decidedly darker.

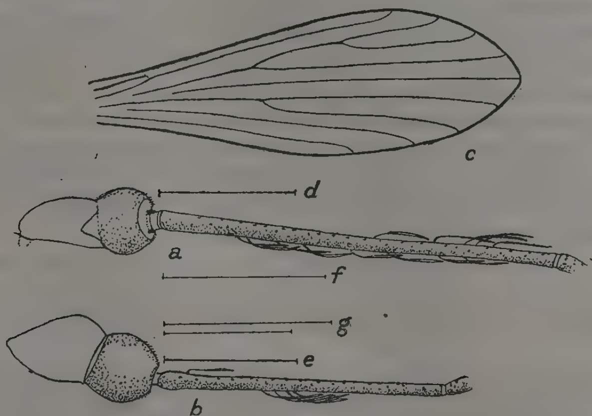

Fig. 2. *Phlebotomus simillimus*, sp.n. ; *a*, proximal portion of antenna of ♂ ; *b*, the same of ♀, × 150 ; *c*, wing of ♀, × 39. *P. minutus*, Rond. ; *d*, line giving relative length of 3rd segment of antenna of ♂ ; *e*, the same of ♀, × 150. *P. minutus* var. *africanus*, Newst. ; *f*, line giving relative length of 3rd segment of antenna of ♂ ; *g*, the same of two forms of ♀, × 150.

♂.—Similar in colour to *P. papatasii*. Abdominal hairs recumbent. Genital armature not differing structurally from that of *P. minutus*, Rond., but larger ; the proximal segment of the superior claspers being about equal in length to *both the segments* of the corresponding appendages in *P. minutus*. The lower or inferior clasper projecting beyond the submedian process to a distance a little less than one-fourth its total length. Antennae (fig. 2, *a*) with the first 3 segments together equal in length to the head, inclusive of the proboscis ; the 3rd segment very long, with the distal portion *projecting beyond the proboscis*. Wings (fig. 2, *c*) relatively broad ; costa and hind margin very similar in curvature ; tip of 1st longitudinal vein extending forwards, so that it overlaps the anterior branch of the 2nd vein by about half its length.

♀.—Generally darker in colour than the male. Antennae with the 3rd segment (fig. 2, *b*) very long, but relatively much shorter than that of the ♂ ; the extremity scarcely reaching to the tip of the proboscis ; geniculated spines present on the 4th to 15th segments inclusive. Wing similar to that of the ♂.

Northern Ashanti : Kintampo, 5 ♂♂, 9 ♀♀ (including type of each sex), all taken in latrines, vii. 1913 ; Nkoranza, 3 ♀♀, on walls of rest-house in damp corners,

17. viii. 13 and 1 ♀, 17. xi. 13; Sekodumasse, 2 ♀♀, on wall of rest-house, 15. xi. 13 (all *Dr. Ingram*). In addition to the foregoing, there were 9 ♀♀ from Kintampo and 5 ♀♀ from N'Koranza, which have not been prepared for critical microscopical examination; so far as one can judge from the dry material they all belong apparently to this species.

Southern Nigeria: Alumu, 18—24, iv, 14 (*Dr. W. A. Lamborn*). Several additional examples labelled, "Southern Nigeria," were also collected by Dr. Lamborn.

Phlebotomus mascittii, Grassi (figs. 3, 4, 5, 6).

Phlebotomus mascittii, Grassi, Att. Reale Accad. Lincei (v) xvii, p. 68, 1908.

I am extremely grateful to Dr. Ashworth for procuring for me a male example of *P. mascittii* from Professor Grassi. This has enabled me to make a detailed examination of all those characteristics which are of taxonomic importance, and to give figures of the genital armature and other structures which are so much needed for comparison and reference. I now find that this and *P. perniciosus*, Newst., are so closely allied as to be separable only with difficulty. The differential characters in these two insects are set forth in the following table:—

	P. mascittii ♂	*P. perniciosus* ♂
Length	3·5 mm.	1·8—2·6 mm.
Superior claspers	With 5 large and 1 small spine.	With 5 large spines only.
Upper branch of 2nd vein ..	2½ times as long as vein between the forks.	1½ times as long as vein between the forks.
No. of examples examined	1.	16.

Grassi (*l.c.*) states that there are 5 spines present on the distal articulation of the superior claspers (*gonapofisi*), two of which at the distal extremity are nearly as long as the segment of the clasper to which they are attached. In the mounted example from Professor Grassi's collection, which I take to be typical of the species and from which the accompanying drawing (fig. 3) was made, there was clearly an additional

Fig. 3. *Phlebotomus mascittii*, Grassi; genital armature of ♂, × 75.

spine (making 6 in all), which he does not mention in his diagnosis. The spine in question arises on the ventral surface a little posterior to the inner lateral pair of spines; but it is much smaller and finer than the rest. In the enlarged drawing (fig. 6, *a*) this spine is shown in dotted line, as, owing to an unfortunate accident,

the whole preparation had to be remounted, and in doing this the small spines broke away, though the points of attachment are still very clearly defined on both the claspers. The wing venation (fig. 5, *a*) is, if constant in a series, strikingly different from that of *P. perniciosus* (fig. 5, *b*), and may in itself serve to distinguish it from the latter. As to the antennae (fig. 4, *a*, *b*) there is a marked difference in the relative length of the 3rd segment in the two species, but when compared with the length of the segments of the palpi or with that of the proboscis both species give the same relative index.

Phlebotomus perniciosus, Newst. (figs. 4, 5, 6).

Phlebotomus perniciosus, Newst., Bull. Ent. Res., ii, p. 70, 1911.

Phlebotomus legeri, Mansion, Bull. Soc. Path., vi, p. 639, fig., 1913.

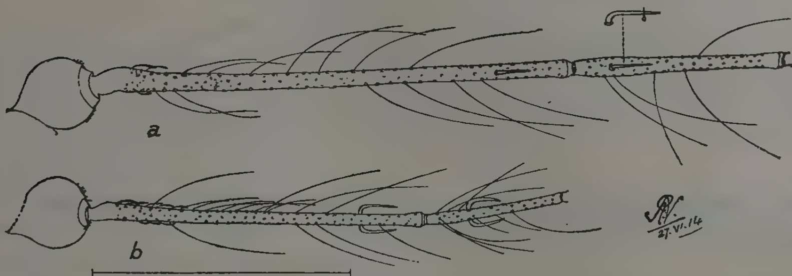

Fig. 4. *Phlebotomus mascittii*, Grassi; *a*, proximal portion of antenna of ♂, × 150. *P. perniciosus*, Newst.; *b*, the same; the line below indicates the length of the 3rd segment in an exceptionally small example from Malta.

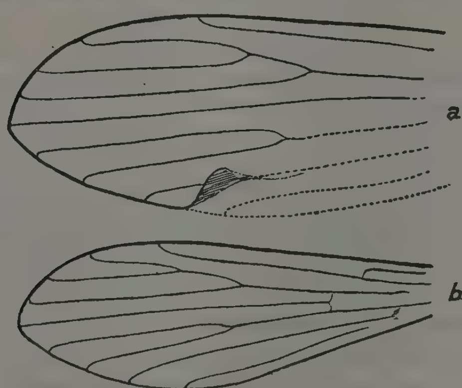

Fig. 5. *Phlebotomus mascittii*, Grassi; *a*, wing of ♂, × 39.
Phlebotomus perniciosus, Newst.; *b*, wing of ♂, × 39.

In the male genital armature the arrangement of the spines on the superior claspers (fig. 6, *b*, *c*, *d*) is often very difficult of interpretation; more especially is this the case when the segments to which they are attached are superimposed, the picture presented

in such cases being a confused bundle of spines arising from various planes. With careful manipulation, however, the superior claspers may be so displayed that the exact arrangement of the spines can be followed with little difficulty. Three distinct phases may be presented: a dorso-ventral view (fig. 6, *b*) with the pronounced lateral spine-bearing processes; an outer-lateral view (fig. 6, *c*), and an inner-lateral view

Fig. 6. *Phlebotomus mascittii*, ♂; *a*, ventral view of distal segment of superior clasper, × 150. *P. perniciosus*, ♂; *b*, distal segment of superior clasper, ventral view; *c*, the same, outer lateral view; *d*, inner lateral view; all × 150.

(fig. 6, *d*). Compare also fig. 17 in the volume of this Bulletin quoted above. Reference has already been made to the length of the 3rd segment of the antennae, and a drawing to the same scale as that of *P. mascittii* is given (fig. 4, *b*); this segment exhibits a slight variation in length, the range in 16 examples amounting approximately to ·075 mm.

As to the synonymy, Mansion's *P. legeri* is clearly the same as *P. perniciosus*, Newst. His excellent figure and clear description leaves one in no doubt as to this, so that the former name must sink.

The following record regarding the geographical distribution of this species is of interest:—

Albania: Scutari (British Detachment), 1 ♂, 21. viii. 13 (*Dr. M. H. Babington*).

Dr. Babington, in a communication which accompanied the specimen, states that "these insects occur in small numbers" and further that "we have had a fair amount of fever, which in Malta we attribute to the bites of sand-flies."

Phlebotomus perniciosus var. **nigerrimus**, Newst.

Phlebotomus nigerrimus, Newst., Bull. Ent. Res., ii, p. 68, 1911.

Since publishing the description of *P. nigerrimus* I have, thanks to Captain Marett, been able to examine several males, all captured by him in Malta. As the taxonomic characters of these agree with those of *P. perniciosus*, Newst., I have come to the conclusion that the former can only rank as a good melanic variety. There is apparently some slight difference in the venation of the wing of the ♀ var. *nigerrimus* (compare fig. 5, *loc. cit.*), which may also serve to distinguish it from typical *P. perniciosus*.

Phlebotomus minutus, Rondani.

Male with abnormal genital armature (fig. 7). Left superior clasper normal,

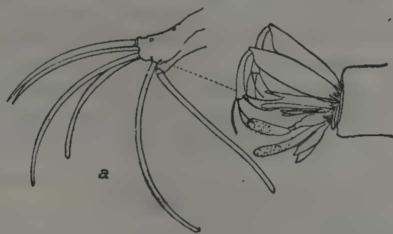

Fig. 7. *Phlebotomus minutus*, Rond., ♂ genital armature; *a*, superior clasper, with supernumary spines, × 225.

right superior clasper (fig. 7, *a*) with three pairs of strong spines; two pairs apical, one sub-apical; the additional spines occupy a superior position and are much more pointed than the others. This is the most singular case of excessive development of the small parts of the genital armature that I have yet seen, and had the additional spines occurred on both claspers I should have unhesitatingly described the insect under a new name.

Tunis: Metlavui, 1913 (*Dr. E. Roubaud*), together with typical examples of both sexes.

Phlebotomus minutus, var. **africanus,** Newst.

Northern Ashanti: Kintampo, 9 ♂♂, 2 ♀♀, in latrine, vii. 1913; Bjere, Volta River, 1 ♂, 1 ♀, in rest-house, 12. ix. 13; Banda, 4 ♂♂, 2 ♀♀, 24. ix. 13; Atabubu, 5 ♂♂, in rest-house, 15. x. 13; N'Koranza, 4 ♀♀, on walls of rest-house, 6 ♂♂, "on unwhitewashed corner of room," 17. xi. 13; Sekodumasse, 3 ♂♂, on walls of rest-house, 15. xi. 13 (all *Dr. A. Ingram*).

The following additional records are based upon an examination of the dry material, so that the exact specific identity of these must be regarded with a measure of doubt:—Kintampo, 8 ♂♂, 1 ♀; Banda, 1 ♀; Atabubu, 3 ♀♀; N'Koranza, 24 examples representing both sexes, many of them imperfect. In addition to the foregoing there are four examples from Kintampo (1 ♂, 3 ♀♀) and one ♀ from Atabubu which are, so far as one can judge at present, referable to this species, but all of them possess such remarkably short 3rd antennal segments as compared with typical *P. minutus* var. *africanus* that I think it desirable to call attention to the fact, though it should be noted that in this respect they do not differ from typical *P. minutus*, Rond., from Malta.

Southern Nigeria: Ibadan, 1 ♀, 20–21. viii. 13, 1 ♂, 2. x. 13, 8 ♀♀, 5. iv. 14; Olumu, 1 ♂, 20. iv. 14 (*Dr. W. A. Lamborn*). Iseyin, 60 m. N.W. of Ibadan, 4 ♀♀, 7. xi. 12 (*Dr. W. S. Clark*); these Dr. Clark informs me were "taken in a rest-house which was rather badly infested with these insects. Many were seen to be resting on the surface of the mud walls, in dark corners, and also under a table."

Ivory Coast: Bingerville, on a lizard, *Agama colonorum*, 1 ♂, 6. xii. 12 (*Dr. E. Roubaud*).

Nyasaland: Mwanza River, Lower Shire, 4 ♀♀, 5. vii. 13 (*S. A. Neave*); only one example has a perfect antenna, but judging from the pointed wings and small size

all belong, I believe, to this species. The dark colour of the specimens is an artifact produced by an accumulation of fine pulverulent dirt. S.W. of Lake Chilwa, Lower Shire, 3 ♀♀, 12. i. 14 (*S. A. Neave*).

PORTUGUESE E. AFRICA: East of Mount Mlanje, 2500 ft., 4 ♀♀, 1 ♂, 5. x. 13; 4 ♀♀, 2 ♂♂, 23–25. xi. 13 (*S. A. Neave*).

TRANSVAAL: Onderstepoort, near Pretoria, 1 ♂, 6 ♀♀, on walls of bathroom, laboratory and latrine, during the months of April to September, 1912-13 (*G. Bedford*).

ANGLO-EGYPTIAN SUDAN: Tokar, Red Sea Province, 9 ♂♂, 8 ♀♀, 1913 (*H. H. King*).

ALGERIA: Biskra, 1 ♂, 4 ♀♀, 1913 (*Dr. E. Sergent*).

Phlebotomus antennatus, Newst.

♀.—Body hairs dull amber-coloured, those on the head and thorax erect, on the abdomen recumbent. Hairs on the wing area bright pale buff to golden buff; costal hairs similar, with black ones intermixed.

NORTHERN ASHANTI: Kintampo, 8 ♀♀, in latrines, viii. 1913 (*Dr. A. Ingram*).

Phlebotomus papatasii (Scop.).

Males with abnormal genitalia. I have examined two examples: one from Rawul Pindi (ex coll. *Dr. J. H. Ashworth*), the other from Malta (*Capt. P. J. Marett*). In both of these examples a supernumerary spine was present on one of the inferior claspers. In typical individuals of this species only two flattened, spathuliform spines arise from the distal extremity of the inferior claspers; so that examples with such supernumerary appendages as those herein recorded can only be regarded as abnormalities.

TUNIS: Metlavui, 1 ♂, 2 ♀♀, x, 13 (*Dr. E. Roubaud*).

ALGERIA: Biskra, 2 ♀♀, 1913 (*Dr. E. Sergent*).

ANGLO-EGYPTIAN SUDAN: Tokar, Red Sea Province, 9 ♂♂, 7 ♀♀, 1913 (*H. H. King*).

Phlebotomus roubaudi, Newst. (fig. 8).

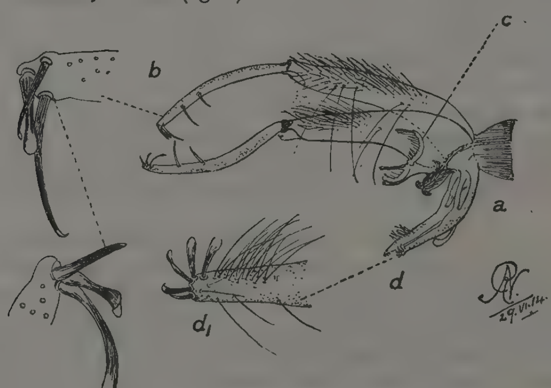

Fig. 8. *Phlebotomus roubaudi*, Newst., ♂;
a, genital armature, × 52; *b*, distal segment of superior clasper; *c*. median fringed process; *d*, d_1, arrangement of spines on the inferior clasper, × 300.

Phlebotomus roubaudi, Newst., Bull. Soc. Path. Exot., vi, pp. 124-126, 1913.

I have recently secured another male of this species, unfortunately without data, but as it agrees in all the structural details with the type, now in the Pasteur Institute, Paris, I have added a few more details and a figure of the armature, so that its differential characters may be more easily followed. On comparing the illustration of the armature of this species (fig. 8) with that of *P. papatasii*,* the marked morphological differences which exist between these two species will be readily seen. The male genital armature is relatively large and in general outline similar to that of *P. papatasii* (Scop.); distal segment of superior claspers (fig. 8, *b*) with 5 spines, 3 at the distal extremity and 2 widely separated from them and also from each other; the former are markedly unequal in length and two of them are broadly dilated and flattened distally, more especially the central one. Inferior claspers (fig. 8, d_1) a little more than half the length of the proximal segment of the superior claspers, apex with 4-5 short stout spines (5 is apparently the normal number); these when viewed dorso-ventrally are seen to be spathuliform, but in profile they appear pointed and simple. Median fringed process (fig. 8, *c*) very small and about *one-third the total length of the inferior claspers.* Thus the armature presents four well-marked characters by means of which it may be distinguished at once from *P. papatasii*; these are set forth in the following table:—

	P. roubaudi, ♂.	*P. papatasii*, ♂.
Distal spines on superior claspers	Three; one about twice the length of the others ..	Three; all of nearly equal length.
Inferior claspers	Slightly over one-half the length of the proximal segment of the superior claspers, approximately	Three-fourths the length of the proximal segment of the superior claspers, approximately.
Number of spines on inferior claspers	Four to five	Two.
Submedian fringed process (fig. 8, *c*)	Scarcely longer than the median paired process.	More than twice the length of the median paired process.

Roubaud's example (type ♂) came from Akjoucht, in Máuretania, French West Africa.

Phlebotomus zeylanicus, Annandale (fig. 9).

♀.—Abdominal hairs, with the exception of those on the proximal segment, recumbent. Abdominal hairs ochraceous grey; those on the head and thorax slightly paler and many with infuscated tips. Wings hyaline; fringe of costa either pale grey (2 ♀♀) and scarcely darker than the hairs on the veins, or infuscated (1 ♀) and much darker than the rest; fringe behind margin pale silvery grey to dusky grey; anterior branch of the 2nd vein, in 2 ♀♀, about two and one-third times the length of the space between the forks. Palpi (fig. 9, *a*) of 5 segments; the 2nd slightly shorter than either the 3rd or 4th; 5th longer than the two preceding together. Antennae (fig. 9, *b*) with the 3rd segment equal in length to the first three segments of the palpi; segments 3-15, inclusive, each with a pair of geniculated spines, and there are also indications of similar spines on the terminal segment.

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* Bull. Ent. Res., ii, p. 74, fig. 18.

CEYLON : Peradeniya, 3 ♀♀, 30. iv. 14 (*A. Rutherford*).

If the foregoing description of the wing is compared with that given by Annandale* it will be seen that there are marked differences regarding the relative length of the anterior branch of the second long vein. Annandale describes this as being "nearly five times as long as the distance between the two forks," though in his illustration (fig. 5) the vein in question is shown as being only slightly more than *three* times the length of the distance between the two forks. In a later communication (§), however, he makes the following statement : "It should ..... be noted that the figure of *P. zeylanicus* printed in my former paper (p. 60, fig. 4) gives, because of the angle at which the wing was drawn, a somewhat incorrect idea of the venation in that species ; fig. 5 on the same page is more exact in this respect." This is somewhat difficult of interpretation, as it leaves one still in doubt as to whether we are to consider his diagnosis as correct or his illustration (fig. 5) ; for the present both must be accepted as indicating exceptional variation in the wing venation. I have ventured to call attention to this because I find, as already stated, that in the examples collected

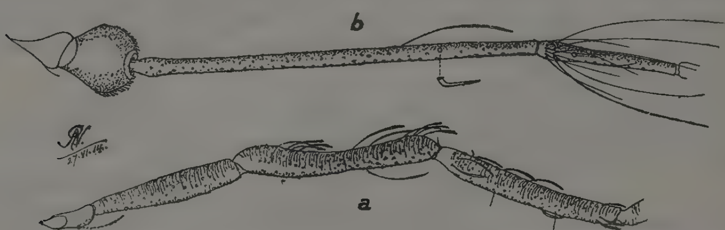

Fig. 9. *Phlebotomus zeylanicus*, Ann., ♀ ; *b*, proximal portion of antenna, × 300 ; *a*, 1st to 4th segments of palpus, × 300.

by Mr. Rutherford the anterior branch of the second vein is only two and one-third times the length of the space between the forks. In other respects the venation agrees, especially in regard to the position of the tip of the first longitudinal vein, which is, as Annandale states, far in advance of the anterior branch of the second. *P. malabaricus*, Annandale, presents a similar wing venation to that of *P. zeylanicus*, but on the whole my examples agree best with the latter. There the matter must stand until more material is available. Pairs in coitu are much needed, and I sincerely trust that Mr. Rutherford will be successful in securing these.

Phlebotomus longipalpis, Lutz & Neiva (fig. 10).

BOLIVIA-BRAZIL BOUNDARY : Abuna River, ♂♂ and ♀♀, 1913 (*Dr. F. D. Walker*).

So far as I can possibly ascertain at the moment there is a measure of doubt as to whether the specimens recorded above are specifically identical with *Phlebotomus longipalpis* described by Lutz & Neiva.† Finding it impossible to determine Dr. Walker's material from the author's description alone, I submitted an example of the male to Dr. Lutz (carefully prepared for microscopical examination). In his reply

* Spolia Zeylanica, vii, p. 60, 1910.

§ *Ibid.*, xxviii, p. 203, 1911.

† Mem. Inst. Oswal. Cruz, iv, p. 90, 1912.

he states: "I received and examined your *Phlebotomus*. It is certainly of the type of *longipalpis*, though I seemed to notice some little differences by comparing another male in microscopical preparation. Those, however, might be due to accidents in

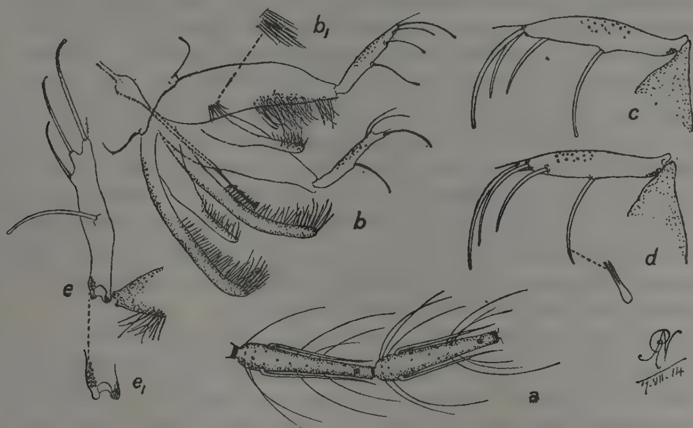

Fig. 10. *Phlebotomus longipalpis*, Lutz & Neiva;
a, 13th and 14th segments of antenna of ♀, × 225; *b*, genital armature of ♂, × 75; b_1, ventral groups of spinose hairs; *c*, outer lateral; *d*, inner lateral; *e*, ventral aspect of inferior claspers, × 150; e_1, proximal portion of *e*, showing group of hair attachments.

position and preparation. The place where it was found speaks also for it, as *longipalpis* has a very wide range. It certainly is not the species of Sophia Summers, nor a larger undescribed one I brought from Southern Brazil, which has the antennae of the same type as *longipalpis*. The new species from Trinidad and Peru . . . . . described by Knab and Townsend have the same type of antennae, but seem to be different, though I do not feel sure about it . . . . . The feet seem rather heavily scaled in your specimens." This leaves one still in doubt as to the specific identity of Dr. Walker's material, the outstanding features of which are so strikingly characteristic that I fail to understand how it was that Dr. Lutz was unable to determine definitely the specimen submitted to him. In view, therefore, of the slight discrepancies which Lutz has observed, and also that there exist in my specimens certain taxonomic characters which have, apparently, been overlooked, it may be desirable to call attention to these, so that in future the insect may be determined the more readily.

♀.—Antennae of 16 segments, the 3rd relatively very short; 5th reaching to the tip of the proboscis; 3rd and 4th together a little longer than the 5th segment of the palpi; geniculated spines present on the 3rd to the 15th, inclusive; those on the 11th-15th (fig. 10, *a*) of great length, the tips reaching to the articulation of the succeeding segment and in some instances slightly beyond; the length of the spines on the other segments not determinable in my preparations, but all of them appear to be unusually long, differing markedly in this respect from those observed in the African and European species. Legs densely scaled, the individual scales long and narrowly lanceolate.

♂.—3rd segment of the antennae slightly longer than the corresponding segment in the ♀; 4th segment reaching just beyond the tip of the proboscis; distal extremities of the geniculated spines on the 3rd-15th segments, inclusive, reaching to or just beyond the articulation of the succeeding segment. Genital armature (fig. 10, *b*): inferior claspers or appendages longer than the basal segment of the superior claspers; the latter (fig. 10, *c*, *d*, *e*) with 4 unequal spathuliform or oar-shaped spines, the three distal ones distinctly separated (*e*) and the terminal one the longest; the 4th, about equal in length to the distal one, arises a little proximal to the centre of the segment; a single fine short bristle is placed slightly dorsal to the distal spine; this rarely breaks away, as do the hairs which clothe the segment; figure 10 (*c*, *d*, *e*) shows three different views of the anterior segment of the superior claspers, the outer lateral, the inner lateral and the ventral, respectively. There is a well-marked group of cicatrices at the base of the segment (fig. 10, e_1), but the spines or hairs are invariably broken away in my material. Basal segment of the superior claspers with a densely packed, linear group of fine hairs or bristles (fig. 10 b_1).

Thus it will be seen there are several well marked characters. The short 3rd antennal segment in both sexes; the long and strikingly characteristic geniculated spines (*a*); the well-marked group of fine spinose hairs (b_1) on the basal segment of the superior claspers; the arrangement of the large spines on the distal segments of the superior claspers and the presence of the fine terminal bristle; and the well-marked group of cicatrices (e_1).

The palpal formula is as Lutz & Neiva describe it in their *P. longipalpis*. If the specimens herein described should eventually prove to be new I would suggest the name *walkeri* in honour of the discoverer.

Phlebotomus stantoni, sp. nov. (fig. 11).

♀.—Length, 2·1 mm. Wing, 1·9 mm.

♂.—Unknown.

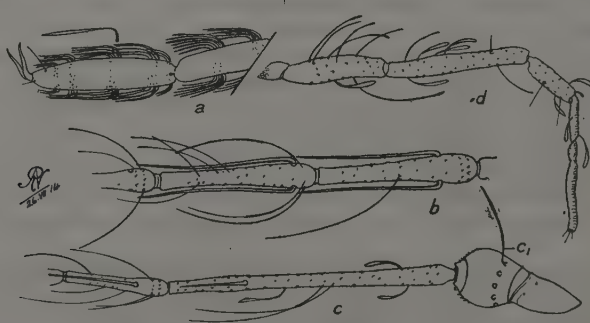

Fig. 11. *Phlebotomus stantoni*, sp.n., ♀;
a, distal portion of tarsus, × 225; *b*, two segments of the antenna, × 225; *c*, proximal portion of antenna; c_1, verticel of hair-like scales, × 150; *d*, palpus, × 150.

A medium-sized species distinguishable by the silvery grey, recumbent hairs on the venter of the abdomen; in the palpi, by the unusually short 4th segment, and

the relatively short terminal segment; by the verticel of long hair-like scales on the 2nd segment of the antennae; and also by the scales on the tarsi being arranged in broad, distinct bands.

Abdominal hairs more or less erect *dorsally*, and arranged in indefinite tufts; *those on the venter recumbent* and silvery grey, standing out in marked contrast to those on the dorsum, which are faintly infuscated. Legs: tarsi clothed with dull silvery scales arranged in complete and well defined bands or zones; when mounted in balsam and examined in optical section the arrangement of the scales (fig. 11, *a*)* is seen to be strikingly characteristic, but it is curious to note that the integument in the inter-zonal spaces is covered with cicatrices, though there is no trace of either scales or hairs arising from any of them. Antennae with geniculated spines on all the segments of the flagellum, with the exception of the terminal one, *i.e.*, 3rd-15th inclusive; these for the most part at least are of great length (fig. 11, *b*), the tips reaching nearly to the bases of the spines on the succeeding segment; 2nd segment (scape) with a single verticel of long stout hair-like scales (fig. 11, c_1); 3rd segment (fig. 11, *c*) long, the tip reaching almost to the tip of the proboscis; hairs relatively long and stout, and the smaller segments of the flagella rather densely clothed with them; sensoria on terminal segments with a few rather conspicuous hairs. Palpi (fig. 11, *d*) rather short and slender; 3rd and 5th segments the longest and about equal in length; 4th unusually short, being a little more than half the length of the 2nd; formula, 1, 4, 2 (3, 5). Wings with the 1st longitudinal vein terminating well in advance of the anterior branch of the 2nd; anterior branch of the 2nd longitudinal vein one and a half times as long as the distance between the two forks; no further particulars can be given, as the margins of both wings are crumpled.

FEDERATED MALAY STATES: Kuala Lumpur, 1 ♀ (*type*), 15. vi. 14 (*Dr. A. T. Stanton*).

Phlebotomus bedfordi, sp. nov. (fig. 12).

♀.—Length, 3 mm.; wing, 1·9 mm.

♂.—Unknown.

A fairly large and somewhat robust species, very closely resembling a large example of *P. minutus* var. *africanus*, Newst., but separable from the latter and also from all the other known African species by the short terminal segment of the palpi (fig. 12, *aa*).

Colour as in *P. minutus* var. *africanus*. Abdominal hairs, with the exception of those on the proximal segment, recumbent both dorsally and ventrally. Antennae: 3rd segment relatively very short and about one and two-thirds the length of the 4th, the tip of the latter reaching to the end of the proboscis; the paired geniculated spines present on the 3rd to the 15th segments inclusive, those on the 14th and 15th extending to or just beyond the articulation of the succeeding segments; those on the lower segments, so far as they are traceable, do not reach the articulations by a relatively considerable distance, so that their form and arrangement are very similar to those found on the other members of the genus elsewhere in Africa; all the segments

* Marginal scales only shown.

with numerous, fine, short outstanding hairs. Palpi (fig. 12, *a a*) with the 4th and 5th segments about equal in length, they are also much the longest, but the 5th is comparatively speaking unusually short; the 3rd slightly incrassate proximally; formula 1, 2, 3 (4, 5). Wings (fig. 12, *b*) lanceolate and relatively narrow; 1st longitudinal

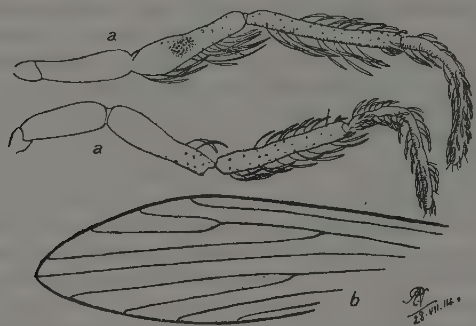

Fig. 12. *Phlebotomus bedfordi*, sp.n., ♀; *a a*, palpi, × 150; *b*, wing, × 39.

vein terminating considerably in advance of the anterior branch of the 2nd; upper branch of the 2nd longitudinal vein shorter than the distance between the two forks, the latter being about one and one-third times the length of the former.

Transvaal: Onderstepoort, near Pretoria, 1 ♀ (*type*), in latrine, 2. vi. 12 (*G. Bedford*).

A NOTE ON PSEUDAONIDIA FOSSOR, NEWST.

By A. Rutherford,

Government Entomologist, Ceylon.

In January 1912, the writer collected in Trinidad, B.W.I., what is in all probability *Pseudaonidia fossor*, Newst. (Bull. Ent. Research, iv, p. 308, 1914). The insects occurred on the twigs of a plant that has been determined as *Ficus comosa*. The leaves of the same plant were heavily infested on the under surface by what is probably *Aspidiotus personatus*, Comst.

My specimens of *P. fossor* show some differences from Newstead's material, the most important of which is that in this case the adult insect is not fossorial. The scales stand up in small groups on the twigs. Otherwise Newstead's description applies quite closely to my insect.

In the specimens before me there are from five to seven gland-pores connected with the anterior spiracles, while similar pores seem to be absent from the posterior spiracles. The pygidia agree closely. The paraphyses, however, are much more distinct than they are represented in Newstead's figure, and between the second and third lobes there is a conspicuous broad plate laterad of the setae, and there are one or two similar plates laterad of the median lobes. These plates are very easily broken off. The median lobes project on their mesal side into the pygidium for a short distance.

The following additional notes may be of interest : The anal orifice is narrow and is surrounded by an area more heavily chitinised than is the pygidium as a whole. The unborn young possess a distinct pair of lobes, each bearing a resemblance to an extended hand. There are two deep notches on the mesal and three on the lateral obliquity near the apex of the lobe. The pygidium is distinctly reticulated and a distinct chitinous ring surrounds the anus, which is close to the apex of the abdomen.

The young individuals are certainly fossorial, the scale being covered by a thin layer of bark. The scale of the adult insect, however, is ~~not~~ conspicuous, and bears quite no resemblance in this respect to *Howardia biclavis*, Comst., with which Newstead compares his specimens. His material was from a different plant (grape vine), and perhaps this accounts for the difference ; but I have never seen *Howardia biclavis* thus influenced by its host plant.

COLLECTIONS RECEIVED.

The thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly presented collections of insects (received between January 1st and March 31st, 1914) :—

Dr. W. M. Aders :—1 Culicid, 7 *Haematopota*, 1 *Ceratitis*, 3 other Diptera, 2 Hymenoptera, 17 Coleoptera, 2 larvae and 2 pupae, 5 Lepidoptera, 2 Anoplura, 6 species of Coccidae and a number of Aphididae ; from Zanzibar.

Mr. T. J. Anderson, Government Entomologist :—341 Culicidae and a number of larvae, about 120 minute Diptera, 8 species of Coccidae, about 1,150 Aphididae, 4 Ticks and 6 Mites ; from British E. Africa.

Mr. E. Ballard, Government Entomologist :—25 Trypetidae and 20 Moths ; from Coimbatore, Madras.

Dr. F. J. A. Beringer, Medical Officer of Health :—45 Culicidae, 67 Siphonaptera, and 9 Hymenoptera ; from the Gold Coast.

Mr. G. E. Bodkin, Government Biologist :—14 Diptera, 778 Hymenoptera, 53 Coleoptera, 2 Lepidoptera, 2 Planipennia, 24 Mallophaga, 6 species of Coccidae, 5 other Rhynchota, 13 Orthoptera, 12 Ephemeridae, 6 Ticks, 8 Chelifers, 3 Scorpions, 6 Millipedes, and a tube containing Intestinal Worms ; from British Guiana.

Mr. E. B. Connell :—70 Hymenoptera ; from Trinidad.

Division of Entomology, Union of South Africa :—1 Oestrid larva, 133 Coleoptera and 3 Orthoptera ; from the Transvaal.

Dr. Mercier Gamble :—19 Diptera, 3 Lepidopterous pupa cases, 323 Ticks, and 1 tube containing Linguatulids ; from the Congo.

Dr. Lewis H. Gough, Government Entomologist :—49 Diptera, 110 Hymenoptera, 2 *Prodenia litura*, 4 larvae and 1 pupa, 22 other Lepidoptera, 3 Myrmeleonidae, 1 Termite, 26 Rhynchota, 9 Orthoptera and 23 Mollusca ; from Cairo.

Mr. C. C. Gowdey, Government Entomologist :—1 *Haematopota*, 80 Hymenoptera, 158 Coleoptera, 2 Lepidoptera, 25 Isoptera, 2 Mallophaga, 30 Thysanoptera, 1 species of Coccidae, 1 tube containing Aphididae, 95 other Rhynchota, 57 Orthoptera, and 16 Ticks ; from Entebbe, Uganda.

Mr. G. F. Hill, Government Entomologist :—30 *Phlebotomus*, 144 other Diptera and 3 pupa cases, 7 Siphonaptera, 510 Hymenoptera, 83 Coleoptera, and 30 larvae and pupae, 10 Odonata, 6 Cimicidae, a number of Aphididae, 39 other Rhynchota, 3 Orthoptera, 2 Thysanura, 2 Centipedes, 1 Millipede, 1 Scorpion, 2 Pseudoscorpions and 3 Spiders ; from N. Territory, Australia.

Imperial Department of Agriculture for the West Indies :—4 Longicorn beetles, 5 larvae and 1 pupa ; from the West Indies.

Dr. A. Ingram, W.A.M.S. :—About 60 *Phlebotomus*, 116 Culicidae, 6 *Hippocentrum*, 7 *Haematopota*, 27 *Tabanus*, 172 *Glossina*, 2 *Stomoxys*, 1 *Hippobosca*, 3 other Diptera, 10 Orthoptera ; from the Gold Coast.

Mr. H. H. King, Government Entomologist :—4 *Chrysops*, 4 Muscidae, 1 Oestrid, 2 Curculionidae, 46 Psyllidae ; from the Anglo-Egyptian Sudan.

Dr. W. A. Lamborn, Government Entomologist :—68 Diptera, and 6 pupa cases, 259 Hymenoptera and 1 nest, 121 Coleoptera, numerous examples of damage done by Coleopterous and Lepidopterous larvae, 44 Lepidoptera, 4 species of Coccidae, and 2 other Rhynchota ; from Southern Nigeria.

Mr. Ll. Lloyd :—22 *Glossina* and 387 puparia, and 1 *Glossina* with *Mermis* parasite : from Northern Rhodesia.

Capt. A. O. Luckman, Assistant District Commissioner :—3 Culicidae, 1 *Haematopota*, 66 other Diptera, 1 Flea, 122 Hymenoptera, 246 Coleoptera, 78 Lepidoptera, 2 Planipennia, 73 Rhynchota, 13 Orthoptera, 257 Ticks and 1 Spider ; from British East Africa.

Dr. R. E. McConnell, Medical Officer :—6 *Culicoides*, 36 Culicidae, 9 *Simulium*, 16 *Haematopota*, 4 *Tabanus*, 18 *Glossina*, 11 *Stomoxys*, 7 *Lyperosia* and 11 other Diptera ; from Uganda.

Dr. Harold Macfarlane, Government Bacteriologist :—2,876 Culicidae ; from Hong Kong.

Dr. J. W. Scott Macfie, W.A.M.S. :—5 *Culicoides*, 21 Culicidae, 1 *Chrysops*, 1 *Haematopota*, 35 *Tabanus*, 76 *Glossina*, 10 other Diptera, 1 Hymenopteron, 1 Psocid, 4 Odonata and 2 Rhynchota ; from Southern Nigeria.

Dr. J. G. Morgan, Medical Officer :—2 *Dorcaloemus*, 22 *Haematopota*, 71 *Tabanus*, 23 *Glossina*, 1 *Cordylobia*, 7 other Diptera ; from Marimba District, Nyasaland.

Mr. S. A. Neave :—10 *Phlebotomus*, 37 Culicidae, 123 *Silvius*, 253 *Chrysops*, 778 *Haematopota*, 1 *Thriambeutes*, 826 *Tabanus*, 19 egg-masses of *Tabanus*, 197 Tabanid larvae and 33 pupae, 49 *Simulium*, 14 *Stomoxys*, 16 *Lyperosia*, 3 *Glossina*, 7 *Cordylobia* and 1 larva, 138 Asilids and prey, 148 Diptera parasitic on Lepidopterous larvae, 173 other Diptera, 3 Oestrid larvae, 10 Siphonaptera, 25 Parasitic Hymenoptera and Lepidopterous Cocoons from which they emerged, 6 Hymenoptera and prey, 1 nest and bees which emerged from it, 3366 other Hymenoptera, 5375 Coleoptera and 1 larva, 342 bred Moths with early stages, 1690 other Lepidoptera, 18 Thysanoptera, 13 Anoplura, 130 Mallophaga, 4 Odonata and prey, 2 other Odonata, 9 Trichoptera, 4 species of Coccidae, 1371 other Rhynchota, 161 Orthoptera, 73 Ticks, 2 Mites and 1 Spider and prey ; from Mlanje, Nyasaland.

Dr. J. E. S. Old, M.O. :—80 *Tabanus*, 1 *Auchmeromyia*, an Asilid and prey, 42 other Diptera, 15 Hymenoptera, 17 Coleoptera, 140 Lepidoptera, 6 Planipennia, 1 Mantispid, 3 Odonata and 13 Rhynchota ; from Port Herald, Nyasaland.

Dr. H. B. Owen, M.O. :—8 Culicidae, 1 *Dorcaloemus*, 9 *Haematopota*, 7 *Tabanus*, 9 *Glossina*, 3 *Stomoxys*, 1 *Lyperosia*, 1 *Auchmeromyia*, 5 *Cordylobia*, 2 Hippoboscidae, 3 Ticks ; from Uganda.

Dr. J. S. Pearson, W.A.M.S. :—16 Culicidae, 85 *Haematopota*, 35 *Tabanus*, 179 *Glossina*, 5 *Stomoxys*, from Sierra Leone.

Mr. A. Rutherford, Government Entomologist :—1 Culicid, 5 *Stomoxys*, 7 *Lyperosia*, 1 *Philaematomyia*, 58 other Diptera, 69 Hymenoptera, 90 Coleoptera, 4 larvae and 4 pupae, 65 Lepidoptera, a number of Thrips, 2 Ephemeridae, 144 Rhynchota, 2 Orthoptera and 13 Ticks ; from Peradeniya, Ceylon.

Dr. H. S. Stannus, M.O. :—37 Culicidae, 4 *Haematopota*, 105 *Tabanus*, 44 other

Diptera, 88 Hymenoptera, 141 Coleoptera, 18 Lepidoptera, 2 Planipennia, 4 Odonata, 110 Rhynchota, and 8 Orthoptera ; from Zomba, Nyasaland.

Dr. A. T. Stanton :—29 Culicidae, 1 *Haematopota*, 3 *Tabanus* and 5 other Diptera ; from the Far East.

Dr. H. Swale :—4 *Pangonia*, 1 *Thriambeutes*, 1 *Auchmeromyia*, 21 other Diptera, 37 Hymenoptera, 30 Coleoptera and 1 Orthopteron ; from Lonely Mine, S. Rhodesia.

Sir Arnold Theiler, K.C.M.G. :—A tube of feather mites (*Pterolichus struthionis*) ; from Pretoria.

Mr. F. W. Urich :—About 65 Scolytidae and a number of larvae, 3 Bostrychidae and 7 specimens of the new Frog-hopper, *Tomaspis flavilatera*, Urich, including the type ; from Trinidad.

Mr. R. C. Wood :—4 Culicidae, 45 *Haematopota*, 45 *Tabanus*, 365 other Diptera, 106 Hymenoptera, 128 Coleoptera, 8 Lepidoptera, 1 Planipennia, 1 Odonata, 7 Rhynchota, 4 Orthoptera and 35 Arachnida ; from Chilanga, Northern Rhodesia.

Dr. J. Y. Wood, W.A.M.S. :—112 Culicidae and 241 larvae and 188 pupae, 4 *Haematopota*, 1 *Tabanus* and 28 *Glossina* ; from Sierra Leone.

Mr. R. C. Wroughton :—1 *Pangonia*, 1 *Haematopota*, 1 *Tabanus*, 110 other Diptera and 1 beetle ; from Natal.

THE AGRICULTURAL PESTS OF THE SOUTHERN PROVINCES, NIGERIA.

By W. A. Lamborn, M.B.

(Plates XVII–XXV).

The following notes embody the results of observations made during a year of service (May 1913 to May 1914) as the Entomologist in the Agricultural Department of the Southern Provinces, Nigeria. They do not, however, pretend to cover more than a very limited area of the Western Province, for on account of the desirability of beginning the work by making myself acquainted with local conditions by a careful study of the insect problems at the head-quarters of the Department, at Moor Plantation, Ibadan, I suggested that the first few months of my tour should be spent there, hoping afterwards to be afforded an opportunity, which unfortunately was not forthcoming, of making a more general survey of the insect pests of the country. I have confined my remarks to insects which are to be looked on as real pests, and have made no reference to the bionomics of other insects which I have observed to be associated with the indigenous flora. I have classified the pests according to the plant attacked, and have added to my account of each notes as to the measures found useful in dealing with them.

Cotton Pests.

Insects attacking the Leaf.

Cotton plants at an early stage were frequently attacked by a leaf-miner, which proved to be the larva of a small Tineid moth, *Acrocercops bifasciata*, Wlsm. (Plate xvii, fig. 10). Good material for study was obtained in the laboratory, where a pot experiment was practically ruined by these pests. The larva generally took a course characteristic of other leaf-miners (Plate xviii), but frequently, when several were present, an extraordinary effect was produced, the whole upper epidermis being lifted up to form one large blister. It is noteworthy that even the cotyledons were often attacked, the consequence being that the vitality of the little plants was very much impaired. The pest is readily destroyed by pinching affected leaves, but if a plant is badly attacked, it is wiser to destroy it.

A species of mite, dull red in colour, was detected in very great numbers, late in the season (January), running about under a very delicate web on the underside of the leaves. The leaves attacked presented a characteristic yellowish mottled dry appearance and ultimately fell. The mite appears to bear a very close resemblance to the notorious " red spiders " of the genus *Tetranychus*, which have been credited with the spread of various fungus diseases, the American " black arm " in particular. My colleague, Mr. C. O. Farquharson, M.A., B.Sc., the Government Mycologist, expressed the opinion that these mites are probably responsible for the spread of " cotton rust " and of a pink *Fusarium*, an organism which is probably concerned in the causation of a disease resembling " black arm " with which the native varieties, and to a less extent imported varieties, of cotton were badly attacked. Mites very similar to these, if not the same, were found abundantly under the leaves of the various species of *Canavalia* and on certain bush plants. No treatment against cotton mite was devised, the question as to the rôle they actually play in the spread of disease being still *sub judice*.

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Colonies of the cotton aphis, *Aphis gossypii*, Glov., which produce a characteristic wrinkling and infolding of the margins of the young leaves, were abundant early in the season (August), but were soon thoroughly checked by natural enemies, the chief of which were found to be Coccinellid beetles, *Chilomenes lunata*, F., *Chilomenes vicina*, Muls., and *Hyperaspis pumila*, Muls., all of which preyed, both as larvae and imagos, on the aphids. The larvae of three species of Syrphid flies, *Syrphus nasutus*, Wied., *Paragus borbonicus*, Mcq., and *P. longiventris*, Bezzi, and the larva of a lace-wing, *Micromus timidus*, Hagen, also ate them voraciously. By far the worst pest feeding on cotton leaf was the short-horned grasshopper, *Zonocerus variegatus*, L. Immense swarms of nymphs appeared suddenly, all about the same time in November, and entirely defoliated numerous plants. But though cotton appeared to be the favourite food, the pests were practically omnivorous and attacked, in addition to a large variety of wild plants, other plants under cultivation, young maize, young Para rubber, cassava in particular (Plate xix), bananas, and a variety of ornamental plants, especially *Acalypha*. Cacao was occasionally attacked, but fortunately was not a favourite food.

The insects gradually scattered as they attained maturity, and in late January completed the last ecdysis (Plate xxv, fig. 2), after which they were to be seen *in coitu* everywhere, and shortly afterwards new swarms of larvae appeared.

The multiplicity of food-plants and the enormous numbers of the pest made the question of dealing with them a difficult one ; moreover it was felt that the use of Paris green, whether as a spray or as a dusting powder, was undesirable from the ginners point of view. Chromate of lead, prepared as recommended by Lefroy, was therefore used in spray form as the lesser evil and it certainly had a deterrent effect, causing the majority of the insects to migrate to new feeding grounds and killing a few. Since the insects are gregarious through the greater part of the life-cycle, it is possible that a trial of d'Herelle's virus might have yielded valuable results, but a supply could not be obtained in time for that season.

The leaf-roller, *Sylepta derogata*, F., occurred abundantly early in the season, about November, on certain imported varieties, American Upland in particular, but were much less numerous on the native cottons, the so-called Ishan and Meko varieties. Tachinid parasites, possibly of two species, an Ichneumonid, *Xanthopimpla punctata*, F., and some BRACONIDAE were bred out from the pupae, but were not numerous enough to be effective in checking the pest. An attempt was therefore made to cope with it by the use of insecticidal sprays, which did not however prove a success, owing to the difficulty of getting the poison on to the rolled-up part of the leaf, on which the caterpillar mainly subsists. Resort was therefore had to hand-picking by small native boys, who collected at the same time the various cotton stainers.

The larvae of the Limacod moth, *Parasa infuscata*, Wichg., were not uncommon, and green half-looper Noctuid larvae were found from time to time, but were not responsible for any great damage, being kept down by the agency of a species of Eumenid wasp, *Eumenes maxillosa*, de Geer, a black household insect very common in the Ibadan district, which stored the larvae as food for its grubs in great numbers, five or six being often found in each of the seven or eight cells composing its nest.

Various beetles, a Lagriid, *Lagria villosa*, F., and the Eumolpid *Syagrus calcaratus*, F., in particular, were found to cause a certain amount of leaf damage.

Insects attacking the Stem.

Two species of scale-insects, *Hemichionaspis minor*, Maskell, and *Pulvinaria jacksoni*, Newst. (Plate xxi, fig. 1) were found on cotton stems, neither in any great

Fig. 1. *Pseudagrilus sophorae*, L.

abundance. The former, a small insect occurring in such great profusion on particular plants as to give at a distance the impression that the branches might have been dusted with a white powder, was frequently found also on a fibre plant, *Urena lobata*, L., on okra (*Hibiscus esculentus*, L.) and various other Malvaceae, and on a species of *Ipomoea*, but, as the season went on, it was much checked by both larvae and imagos of a Coccinellid beetle, *Chilocorus schiödtei*, Muls., which occurred abundantly, and had a gregarious tendency, even pupating close together. The *Pulvinaria*, a species recorded also as a cotton pest in Uganda, was much less numerous, being found here and there only in a ten-acre plot of Griffin cotton.

The larva of a small green Buprestid beetle, *Pseudagrilus sophorae*, L., (fig. 1) caused considerable damage and some loss of plants owing to its habit of boring the stems. The appearance produced in the plants was characteristic. When a young plant was attacked general stunting and distortion with shortening of the internodes was produced, and the uppermost leaves failed to attain full size, though the lower ones were to all intents normal in this respect (Plate xx). Young plants attacked did not as a rule die, but often went on to produce undersized imperfect bolls. Older plants became sickly and tended to shed their leaves. On examination of the stem of such a plant the point of entrance of the grub could usually be found near the ground, so that it is here, in all probability, that the parent beetle deposits its egg; the grub then bores in the cambium for 3 or 4 inches to and fro in a very characteristic zigzag manner, filling up the tunnel behind itself with pink sawdust-like excreta. The course it takes in the cambium explains how it is that the plants do not die as a result of the attack but suffer only from impairment of vitality. The larva then proceeds to tunnel straight up in the wood for a distance of about 12 inches, usually in the main stem, but often in one of the larger limbs, and when full-fed penetrates to the pith cavity, where it comfortably pupates in a little bed on the soft pith, though occasionally in the wood. In due course it turns into a beetle, which reaches the outer world by boring, such holes of egress being readily found high up on the stem of the plant.

No method of coping with this pest, other than by destruction of affected plants, was devised. Another stem-borer found late in the season was a Lepidopterous larva, possibly an Aegeriid.

Insect Pests attacking Cotton Roots.

The larvae of a Lamellicorn beetle, recorded for the first time in 1910 by Jemmett as attacking cotton roots, were responsible for the loss of a number of plants. The symptoms of their presence were a gradual withering of the leaves, which then turned red and fell, a slow drying of the stem, premature opening of the bolls, and ultimate death of the plant. The roots of the plant were then found to be decorticated, and there was usually a redundancy of new tissue at the junction of the healthy and attacked parts.

With a view to combating the pest, experiments in the application of a 1 in 200 aqueous solution of carbon bisulphide to the roots by means of the Gastine apparatus were undertaken in collaboration with the Assistant Director of the Department, and the results were distinctly promising, some plants which were apparently dying having subsequently put out new leaves and recommenced to grow. The plot of cotton especially attacked by this pest had borne a similar crop in the previous season. Doubtless the loss would have been less had there been a change of the crop on it, for the beetles and their larvae possibly lie dormant in the ground during the unfavourable conditions of the dry season.

Insects attacking Cotton Bolls.

The red bollworm, *Diparopsis castanea*, Hmp., occurred abundantly. The life-history of this well-known insect has already been worked out by several entomologists, and my observations accord with what I have read, but there is one important feature characteristic of the insect in Nigeria, namely, that whereas in the majority of cases pupation lasts eight to ten days, yet a small number of instances occur in which the pupa may lie dormant in the ground for many months. Some of these bollworms which buried themselves in earth in my laboratory in October were still in late May, when I came away, in the resting pupa condition, though moving actively at a touch, obviously a provision of nature to ensure the preservation of the species through the adverse conditions of the dry season.

The life-history of *Earias biplaga*, Walk., the other common bollworm, was not definitely worked out, though larvae of all ages were from time to time found not only in bolls, but at an earlier stage in flower-buds. They were found also feeding on the eaves and in the seed-pods of the fibre plant, *Sida carpinifolia*, L., also of the family Malvaceae, as well as on the leaves of several bush plants.

The full-fed larva, which measures about ¾ inch in length, is dull brown in colour and is characterised by the presence of four pointed tubercles on each segment, so situated as to form dorsal and sublateral longitudinal rows. The colour of the larva, the presence of these tubercles, and the fact that it is often found as a leaf-eater seem to indicate that its boll-boring propensities are a recent development, probably dating from the cultivation on a large scale of cotton in the country.

Though no natural enemies were discovered in the case of *Diparopsis*, a species of Eumenid wasp, *Rhynchium ventrale*, Sauss., a black insect with a red tip to its abdomen, was found to act asan important check on *Earias*. This Eumenid was for a very long time confused by myself with other very similar insects, *Synagris calida*, L., *S. spiniventris*, Ill., and *Rhynchium synagroides*, Sauss., until I noticed a wasp on the wing carrying an *Earias* larva. It was seen to enter a cylindrical tube of mud

attached to a wall, and on breaking this away a boring was discovered, which was found to lead into a branching passage enclosing several closed cells, in which were Noctuid larvae of two species, *Earias biplaga*, and a form unidentified. Further observation led to the discovery of many similar tunnels, and in the light of this fact I observed the wasps in the cotton fields, and found them actively searching for this particular prey.

Two other species of bollworm, *Pyroderces simplex*, Wlsm., and a new species of the family GELECHIADAE, described by Mr. J. H. Durrant under under the name of *Mometa zemiodes*, gen. et sp. nov. (see p. 243), were also studied. Though *Pyroderces* was quite abundant, and is now for the first time recorded from Nigeria, it was obtained as long ago as 1885 in the Gambia by Sir Gilbert Carter, where also the larva was found attacking maize. A full description of the insect by Mr. J. H. Durrant has already appeared in this *Bulletin* (Vol. iii, pt. 2, p. 206, Aug. 1912).

Both these two bollworms are small bright pink caterpillars which were found for the first time in June abundantly in belated bolls on plants of the previous season, but were not seen again until the cotton season was well advanced.

Whereas *Diparopsis* and *Earias* bore into unopened bolls and eat away both the immature lint and seeds, the two pests under consideration confine themselves solely to the seeds in opened bolls, eating out the substance till only the husk remains; they are not therefore productive of damage to the same extent as the other forms, though their activities continue even when the unginned cotton is stored away in bags and they may be found alive in seed even after ginning. The larvae were found occasionally also in waste seed scattered about the ginnery.

Both the larvae are much subject to attack by a Chalcid parasite, *Chalcis olethrius*, Waterston, sp. nov. (see p. 257), many of which were bred out in the laboratory. No method of controlling the pests other than by collecting and destroying affected bolls was devised. At the end of the season, when the plants are pulled up and destroyed, the soil should be carefully and thoroughly dug up and turned over with a view to exposing the aestivating *Earias* pupae.

During the dry season the Pyrrhocorid bug, *Dysdercus superstitiosus*, F., was found in some numbers, many even then *in coitu*, sucking up the secretion from the nectaries of *Urena lobata*, and at this time they appeared to be able to thrive on almost any food, whether of animal or vegetable origin, for eight or ten were noticed feeding on a dead and sun-dried lizard and a batch of young nymphs was found on sheep's excreta. They are able to support themselves also on various fallen and dried bush seeds. Later on these cotton stainers were to be found in large numbers feeding on the heads of guinea corn, fifteen feet high, where it was impossible to reach them, and even on ordinary grass panicles. A very decided preference was shown for okra, a few plants which happened to be growing near cotton and with their fruit at a more advanced stage, being simply covered with the insects.

It is a rather singular fact that the black-banded cotton stainer, *Dysdercus nigrofasciatus*, Stål, previously reported as a fairly abundant pest, did not appear until late December, and then only in very small numbers; neither were the two remaining stainers, *D. melanoderes*, Karsch, and *Oxycarenus dudgeoni*, Dist., at all numerous.

The latter was found to be a late season pest, breeding in opened bolls and attacking the seeds. It was frequently found in lint removed from the bolls put aside for the purpose of ginning. The enormous numbers of *D. superstitiosus* (49,000 were collected in November from 46 acres) were to be accounted for, in my opinion, by their swarming in from the farms and bush adjoining the plantation, attracted to their favourite food-plants.

A fact of much interest is that *D. superstitiosus* and *D. melanoderes* occasionally interbreed, for a male of the former species was taken *in coitu* with a female of the latter from which eleven offspring, all *superstitiosus*, were reared in the laboratory, a result in accordance with Mendelian expectation. The life-cycle in the laboratory, from egg to imago, occupied 29 days only, though a previous observer has recorded 68 to 72 days as its duration, and it seems to me quite probable that under natural conditions with an abundance of fresh food the period would be even shorter. My own observations confirm a previous statement that *superstitiosus* oviposits in the ground and not, as would be expected, on the food-plant, and the newly hatched larvae feed on any cotton debris they can find, and then, crawling up the stems, find their way to the bolls.

Small nets were successfully employed for collecting immature wingless stainers, which, congregating on bolls and at the extremities of the branches, were readily shaken off. Many were shaken by small boys into wide-mouthed tins containing water and a small amount of kerosene, a method suitable for the native farmer. The large stainer net, as used in the West Indies, was thoroughly tested, but was not found to have any real practical value against the Nigeria insects, for the adult stainers only fell off when the plant was shaken excessively, to such an extent as to render damage probable, and more often than not they took to flight instead of falling. Moreover, the methods of cultivation and the habit in growth of the cotton plants under trial did not permit the ready use of such an appliance.

Hand-picking seems likely to prove the most efficacious method of controlling the pest. By hand-picking 49,453 stainers, the great majority of which were mature breeding insects, with 7,081 larvae and 2,120 pupae of the leaf-roller, *Sylepta derogata*, were collected in the month of November from the 46 acres under cotton, at a cost of £4, so that if the labour of small boys is utilised, the method can hardly be considered an expensive one. Probably if a larger gang than ten had been put on to the work earlier in the season, the results would have been even more effective. Hand-picking has the advantage also in that other pests, *e.g.*, the leaf-roller, can be dealt with at the same time ; but for the method to be really effective, it would be essential that there should be co-operation, year after year, among all the farmers in the cotton districts. Evidence of the value of the measure was afforded by the excellence of the cotton grown, which, in spite of attack by these pests in hordes, was yet awarded by the British Cotton Growing Association the prize annually offered for the best cotton grown in countries in which they have interests.

Some General Remarks on Cotton.

Mixed cultivation, as was pointed out by Jemmett in 1910, certainly has the advantage of decreasing the spread of insect pests. Other Malvaceae should obviously not be planted in the vicinity of cotton, unless it is intended to collect pests on them,

for *Urena* and the various species of *Hibiscus* serve to attract them almost as much as cotton itself, and moreover the cotton scales flourish on all these plants. Okra, in particular, might probably be planted with great advantage as a trap crop by means of which early collecting of stainers and leaf-rollers could be carried out, for the latter breeds as freely on this as on cotton.

It was noticeable at Moor Plantation that hybrid cottons planted in long narrow plots between belts of maize were relatively free from insect attack as compared with that planted in broad open fields, and it seems highly probable that this freedom from insect attack was due to the influence of the tall maize in preventing the wafting abroad of the odours which serve to attract insects either to feed or to oviposit.

Many visits were made to native farms for the purpose of studying their cotton. Native farmers do not as a rule appear to appreciate that one good sturdy plant is likely to produce better and more abundant bolls than a number of feeble, undersized plants, and they often have as many as eight or ten sickly plants all springing from the same spot, a condition noticeable even on farms actually adjoining Moor Plantation.

The farmer habitually leaves the lint unpicked long after the bolls have burst open, his idea being to gather it all in at one picking instead of by repeated pickings. It then becomes stained and deteriorated in quality, the result being that the cotton stainer gets some unmerited blame, and the commercial repute of the lint is likely to suffer unnecessarily. Well after the cotton season, in May, it was noticeable that on many farms the cotton plants were still left in the ground and that late bolls were unpicked and were absolutely infested with bollworm, stainers and other pests.

It is highly desirable that all old plants should be pulled up and burnt, with a view to keeping down these insects, but if the plants are allowed to remain for a second season, the old bolls should certainly be destroyed, when picking is not being regularly carried out. Legislative measures to enforce these precautions have been brought in in all the great cotton-growing centres.

Cacao Pests.

Insects attacking Cacao Leaf.

Colonies of a species of Psyllid, *Udamostigma tessmanni*, Aulm. var., occurred frequently on the growing shoots of young plants and were successfully combated by brushing with kerosene emulsion.

Black Aphids were found from time to time on the stems of young yellow pods, and on the under side of young leaves, producing a characteristic infolding of the margins, axial rotation of the leaf, and unusual crispness of the leaf substance. At Agege, the cacao centre of the Colony, 12 miles north of Lagos, the larvae of two species of Syrphid flies and the larvae of a Lacewing, preying exclusively on the Aphids, were found in abundance. Many of the aphis colonies, composed both of imagos and immature forms, were found to have died *in situ*, as if from disease, so that the natural agencies checking the pest were thoroughly effective.

Young plants were to some extent attacked by the grasshopper, *Zonocerus variegatus*, already mentioned as a cotton pest, but the principal insect scourge, as in previous years, was the Rutelid beetle, *Adoretus hirtellus*, Castn., which feeds by night, nvariably attacking young plants, and hiding by day, often about the roots. A

second leaf-eating beetle, found in some numbers in the early morning was a Melolonthid, *Trochalus carinatus*, Schönh.

A species of basket worm, the larva of the Psychid moth, *Metisa sierricola*, White, (Plate xxiii), was to be found occasionally eating cacao leaves. The wonderful power possessed by the legless, wingless females of this family of attracting the males was repeatedly shown by the assembling of males, often to the number of forty or fifty and always in the early morning, to a newly emerged captive female.

The caterpillar of the Arctiid moth, *Diacrisia maculosa*, Cram., was also found attacking the leaves, and is probably the most important pest next to *Adoretus*. The larvae of a small Noctuid moth, *Earias citrina*, Saalm., were also observed on the leaves of young cacao plants. Though larvae of the Hesperid, *Rhopalocampta forestan*, Cram., have been recorded as cacao leaf pests in Nigeria, they were not in evidence on cacao during the past season, though they were collected in large numbers from a bush plant by the Eumenid wasp, *Synagris spiniventris*, Ill., which stores them exclusively as food for its larvae. The red tree ant, *Oecophylla smaragdina longinoda*, Latr., which occurred on the larger plants abundantly and is highly combative, probably plays a most useful part in keeping off the various insect pests other than COCCIDAE. Its presence probably accounts for the fact that only young plants which it does not frequent, are attacked by leaf pests, for the latter do not cause appreciable damage to older and well established plants.

In regard to the measures adopted against the leaf-eaters, in the wet season the plants were dusted with a mixture of Paris green and lime, a measure attended with good results. Later on, spraying with chromate of lead solution was adopted instead, owing to the liability of Paris green to scorch the young and tender leaves.

Insects attacking the Stems.

The only stem-borers found were the larvae of the Megalopygid moth, *Eulophonotus myrmeleon*, Feld. (Plate xvii, figs. 7, 9), the only representative of the MEGALOPYGIDAE known to occur outside America. The larvae usually tunnel medium-sized branches, causing a gradual impairment of vitality, so that the leaves droop, then wither and fall, and the branch itself ultimately blackens and dies. The cause of the condition is readily determined by finding at the junction of the healthy and diseased parts of the branch a circular orifice, covered up with sawdust-like droppings held together with silk, which leads into a tunnel containing a white maggot-like larva or a brown, spiny pupa. It is unusual for the main stem to be attacked. In the Onipe district, about 15 miles due south of Ibadan, this species occurred in abundance, nearly every tree yielding one or two specimens.

These boring pests are well known to the farmers in the cacao-growing district, and it is their practice to lop affected branches, leaving them on the ground. This probably makes little difference to the well-being of the borers, which can thrive in freshly dead wood if moisture is present, so that to destroy the pests it is necessary to burn such branches ; though if found before much damage is done, an easy method is to push a flexible wire up the tunnels, subsequently plugging and tarring the hole. With a view to killing the larvae tunnelling in main stems, injections of carbon bisulphide were made into the bore-holes and they were then immediately plugged with a pellet of clay and tarred. This measure also seemed to be attended with good results.

The boring beetle recorded as attacking cacao on the Gold Coast was not found, though special search was made for it.

Some of the trees at Agege, in September, showed evidence of attack by other insects, probably Lepidopterous larvae, which had fed in the deeper layers of the bark. No specimens were then obtainable, but the offender is almost certainly the larva of an Aegeriid moth, the damage being precisely similar to that produced by larvae of this family on the cashew and on a species of *Albizzia*, such as, *Melisomimas metallica*, Hmp., sp. nov. (see p. 245). Such larvae are particularly subtle in their mode of attack, for they eat away the deeper layers of the bark, re-inforcing the superficial layers on the underside with silk, which prevents any very obvious surface indications of the mischief which is proceeding, the result being that areas as large as the palm of one's hand are eventually denuded. The material covering the pest was scraped away, and then the exposed surface was tarred with a view to preventing fungus attack.

The notorious bark-sapper, *Sahlbergella theobroma*, Dist., a Capsid bug figured and described by Dudgeon in a previous number of this Bulletin (vol. i, p. 60, Plate viii) from specimens taken on the Gold Coast, occurred sparingly in the Onipe district, near Ibadan. It is, as I was informed by Mr. C. O. Farquharson, the Mycologist, who is familiar with the insect, a serious menace to the cacao in the Eastern Province, a district which I was not afforded an opportunity of visiting myself.

Small Bostrychid beetles and their larvae were found occasionally boring in dead cacao limbs. It may here be said that beetles of this family in Nigeria are to be found boring in living as well as in dead wood, quite commonly in *Hibiscus rosasinensis*, and in *Melia azedarach*, a fact at variance with the usually accepted account of their habits.

Cacao Scale-Insects.

Several species of this family, some of which have been noted as pests in other cacao-growing areas in Africa, were found, though none occurred in any great abundance. A *Dactylopius*, either *longispinus*, Targ., or *virgatus* var. *madagascariensis*, Newst. (Plate xxi, fig. 2), was found here and there on the growing shoots of young plants at Moor Plantation and on the flower-stalks and small pods at Agege. As has been recorded elsewhere (Trans. Ent. Soc., 1913, p. 475) both these scales are effectively checked by the larvae of the Lycaenid butterfly, *Spalgis lemolea*, H. H. Druce, which was actually carrying out this useful work at Agege. At Moor Plantation this scale was successfully treated by brushing the affected area on each plant with kerosene emulsion, a method which in the case of small plants is certainly less prejudicial than spraying.

Stictococcus sjöstedti, Newst., one of the recognised cacao pests of Western Africa, was found both at Moor Plantation and at Agege, at the latter place protected by the large red ant, *Oecophylla*. The natural enemies of this scale already recorded in Nigeria (Trans. Ent. Soc. 1913, pp. 491 and 493) are the larvae of the Noctuid moth, *Eublemma ochrochroa*, Hmp., and of the Tortricid, *Tortrix callopista*, Durrant. A third larva was also found eating the same species of *Stictococcus* on the fruit of a species of *Napoleonica*. At Moor Plantation, though not at Agege, this scale showed evidences of parasitism by Chalcids.

Another *Stictococcus*, *S. dimorphus*, Newst., occurred on cacao at the Agege plantation, especially on the new shoots, and less on the native farms, a fact doubtless to be accounted for by the use for shade purposes of the pigeon pea plant, *Cajanus indicus*, on which this particular scale is to be found in great profusion. It was greatly checked by a Noctuid larva, *Eublemma scitula*, Ramb., of the sub-family Erastriinae, the larva, as in the case of *E. ochrochroa*, concealing and protecting itself under a shield largely composed of the shells of its victims.

Another scale, which was common on pigeon pea and found from time to time on cacao, was a species of *Icerya* (Plate xxiv, fig. 1).

Insects attacking the Pods.

A small Lymantriid caterpillar was found sparingly eating the superficial layers of the cortex, but doing little direct damage, though probably paving the way for fungus attack.

Fig. 2. *Araecerus fasciculatus*, de G.

Some Anthribid beetles, *Araecerus fasciculatus*, de G., were bred from larvae boring in the husk and a Lepidopterous borer, the larva of *Characoma stictigrapta*, Hmp., (Plate xvii, fig. 6) was also not uncommon. The caterpillar of this insect bored exclusively in the husk, its track being betrayed by patches of black rot of the superficial layers, consequent on the undermining, and by the discharge through various rounded apertures of frass held together by silk. When full-fed, the larva spins a cocoon in the thickness of the husk and there pupates.

The scale-insect *Stictococcus dimorphus*, Newst., occurred fairly frequently on the larger pods, more particularly on those of the yellow Amelonado variety, where they were assiduously guarded by the red ant (Plate xxii). This scale causes the cortex of the pod to rot in small black circular areas, on which a white floury amorphous powder, possibly due to the drying of some secretion, is found after the scale has fallen off, and it certainly paves the way for fungus attack.

Some Trypetid flies, *Ceratitis nigra*, Grah., were captured in great abundance in the cacao fields at Agege during a short visit in late April, but did not permit of an investigation into their relation to the pods. Another undetermined species was also obtained in the same neighbourhood, ovipositing in the fruit of a bush plant.

Termites.

White ants eating away dead wood on the cacao trees at Agege were numerous. No species attacking living wood was found, though, as the dead material is eaten

away, it is probable that more and more of the living material behind it gradually dies owing to the removal of the protective covering, or from fungus attack, so that from small beginnings serious damage may be produced.

It has been a vexed question in the colony as to whether any of the species of termite will attack the roots of living cacao and rubber. From such observations as I have been able to make I see no reason to suppose that this is the case, except in a very dry season, when they may attack living tissues for the sake of the moisture in them.

Dead plants on native farms are rarely removed until they become infested with termites, and frequently in the case of dead trees no definite cause other than this can be seen, but I was informed by the Mycologist that the termites almost invariably follow close behind fungus disease, the presence of which the native farmer of course has not appreciated.

One of the large black Ponerine ants, *Paltothyreus tarsatus*, F., plays a useful part in attacking and carrying off termites on every possible occasion.

The termites were successfully combated by means of the "Universal Ant Destroyer," a machine by means of which arsenical and sulphurous vapours, with a mixture of carbon monoxide and dioxide, are pumped into the termitarium.

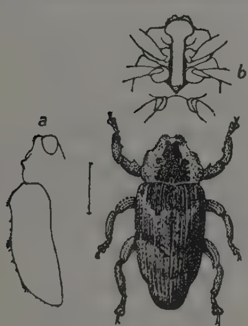


Fig. 3. *Paremydica insperata*, Fst.; *a*, dorsal outline; *b*, head and thorax seen from below.

Fig. 4. *Balanogastris kolae*, Desbr.

Insects attacking Kola.

A Delphacid, *Pundaluoya simplicia*, Dist. (see p. 242), was found quite commonly in all stages of development at the tips of young shoots. They were treated by brushing with a weak kerosene emulsion. Young nursery plants were, like cacao, much attacked by the *Adoretus* beetle, which produces the same characteristic damage to the leaf, and by various grasshoppers, the chief of which was *Zonocerus variegatus*, L. A considerable variety of other leaf-eaters were found, but none was responsible for any great damage. The usual stomach poisons were employed against these pests. Kola nuts, both on the tree and in store, were considerably attacked by weevils, *Paremydica insperata*, Fst., and *Balanogastris kolae*, Desbr., which in turn were parasitised by an Ichneumonid.

Insects Attacking Coffee.

Only one leaf-eater of any importance, the larva of the Drepanid moth, *Metadrepana glauca*, Hmp. (Plate xvii, fig. 4), was found, and this solely at Agege. The caterpillar is dull green, with a lighter coloured bulbous expansion of the thorax, and a long black whip-like tail.

The Coreid bug, *Riptortus tenuicornis*, Dall., previously recorded as a pest, was not in evidence this year on coffee, though it was obtained in great numbers on a small low-growing Leguminous plant.

Various scale-insects, *Stictococcus* in particular, were found on young shoots, but by no means in abundance, and were protected by the *Oecophylla* ant.

Maize Pests.

Leaf-eaters.

The most important pests attacking maize in the leaf were Lepidopterous larvae. The life-history of one of these, *Prodenia litura*, F., was worked out. The female parent deposits her eggs *en masse* on the underside of a maize leaf, protecting and concealing them with a downy material composed of hairs and scales from her abdomen. The larvae hatch in three days, and immediately commence to eat away the superficial layers of the leaf so that it exhibits translucent patches and becomes withered; they then gradually scatter and as they become stronger eat away the whole thickness of the leaf. When about two-thirds grown, at the 13th to the 16th day, the larvae, which are brown, show a tendency to conceal themselves in the heart of the plant; this is of interest as showing a possible step towards the development of actual boring habits. It is at this stage that most damage is done, for often the only indication of their presence is the withering up and ultimate death of the growing shoot, which on examination is found to be eaten through towards the base. When full-fed, towards the middle of the fourth week, the larva buries itself in the ground and, forming an earthen cocoon, pupates, the fully developed insect appearing about eight days later.

The larva of the Noctuid *Cirphis loreyi*, Dup., and that of a species of *Plusia* were found frequently on maize leaves, and there were quite a number of other species not sufficiently numerous to be considered pests. Two species of Lymantrid caterpillars devote their attention to the silk, eating it away flush with the apex of the cob, an attack which, if it occurs before fertilisation has taken place, must lead to total failure of the cob. The earwig, *Elaunon erythrocephalus*, Oliv., was responsible for some damage to green maize. The species seems to be of gregarious habit, isolated specimens being rarely found, and their attack on a plant produces a very characteristic appearance, which, when once seen, can always be detected at a glance. The growing shoot loses tone, droops and becomes withered, and on separating the leaves one finds earwigs congregating in and about holes bored into the leaves and stem. This leads to the plant dying back as a rule, but it seems to recover and recommences to grow, and as the new leaves attempt to force their way through the holes in the old ones, they become restrained and distorted. These earwigs actually breed on the plants, and it is no uncommon thing to find a female parent brooding over a batch of ten to fifteen light yellow eggs, or much agitated at the prospect of danger menacing the young family over which it mounts guard with exemplary solicitude.

Pests attacking stems and cobs.

The chief of these was a dirty-grey caterpillar, the larva of the Noctuid moth, *Sesamia calamistis*, Hampson (Plate xvii, fig. 1). Another species, which is almost equally numerous, is the larva of the Pyralid moth, *Eldana saccharina*, Walk. (Plate xvii, fig. 2), a white maggot-like caterpillar with black head and prothoracic plate. A third borer found occasionally in the stems was the larva of the Noctuid, *Busseola fusca*, Hampson (Plate xvii, fig. 3), which is one of the principal borers in maize in South Africa. The effect produced by these borers varied with the age of the plant. Young plants withered and sometimes died, but older plants survived, though they showed the results of the attack by their stunted growth and withered appearance, and by the failure of the cobs to develop and mature satisfactorily. A large number of malformed cobs examined at Agege showed larvae, pupae or pupa-cases at the core.

When plants bearing cobs are attacked the caterpillars seem to prefer the cob to the stem, but the mode of attack is different in each case. *Sesamia* usually feeds away at the heart of the cob, not as a rule touching the seeds, and when full-fed, pupates in this situation. The damage done to the seed is therefore indirect. *Eldana*, on the other hand, prefers to eat the grains, through which it tunnels here and there, pupating eventually in a white silken cocoon, firmly bound up in the seed, though such cocoons may sometimes be found between the layers of the husk.

The two common species, *Sesamia* and *Eldana* are both checked by a Tachinid fly, which was especially abundant at Agege, though its influence as a check was found to be reduced owing to its being itself much subject to attack by Chalcid parasites—a new species of the family ENCYRTIDAE. A fact of great importance is that these two larvae were to be found even in maize stems left standing in the field long after the cobs had been picked. These stems often possess vitality enough to put out new green shoots, which may continue to grow for weeks after the cobs have been removed. The larvae of *Sesamia* and of *Busseola* were also found as borers in the stems of the coarse grass found so abundantly in the Ibadan district, and moths from larvae in the grass were bred out in the laboratory.

The bright pink larva of another Noctuid works havoc in a particularly subtle way, by feeding just inside the apex of the cob on the silk, which may then fall out. Fortunately its attentions were not limited to young silks, but extended also to older ones, in which case as the seeds were already fertilised it could do little harm. When full-fed these caterpillars spun their cocoons in the remains of the silk and these were readily obtained by gently pulling the silks, which then usually came away quite easily in one's hand. These larvae are frequently parasited by TACHINIDAE, the pupae of which were often found in the cocoons, but the Tachinid pupae in turn are often infested with Chalcids. This pest was much more abundant in Agege than in the Ibadan district.

Towards the end of the maize season a further caterpillar pest, the larva of the Pyralid moth, *Mussidia nigrivenella*, Rag. (Plate xvii, fig. 5), was to be found here and there in the almost ripe cobs. Some importance is to be attached to it in the field, for this insect is one of the chief pests attacking stored grain and is indeed responsible for almost as much damage as the various grain beetles, infection in the first place taking place in the field, and subsequent generations feeding up in the store.

The pests which cause most damage to maize in the fields are the cob and stem borers, with which it is almost impossible to deal directly, though, as pointed out by my predecessors, their numbers could certainly be reduced by a cleaner system of farming. The maize on the native farms is as a rule allowed to remain in the field long after it is ripe, so that it becomes infested with caterpillars and weevils; it should unquestionably be harvested as early as possible and then the husks and stems should be disposed of. The native practice of leaving the stems still standing in the fields and of training up the yam vine on them cannot be too strongly discouraged, for, as already pointed out, the borers continue to feed and thrive in these partly dead stems. When the cobs are stripped, also, the husks are littered about, many containing larvae and pupae of pests.

The ideal method of disposing of maize refuse would be to burn it, but as this was felt to be undesirable from the point of view of sound farming, a series of experiments were made with a view to testing how far the burial of refuse, or its inclusion in compost heaps would result in destruction of the pests. It was found that borers in maize and guinea-corn refuse perished when it was buried under a few inches of earth in the wet season, when doubtless bacterial action and other fermentative changes set up in the fluids in the stems would accelerate their death. Formation of the refuse into a compost heap was also equally effective.

The problem of the control of these pests therefore resolves itself into (*a*) harvesting as early as possible, and (*b*) clean farming; and if these are practised, there are likely to be fewer pests in stored grain.

Pests Attacking Stored Maize.

On my arrival in late May, maize in the store was found to be severely attacked by the common grain weevil, *Calandra oryzae*, L., the Tenebrionid *Tribolium confusum*, the Trogositid *Tenebrioides mauritanicus*, L., and by a fourth smaller brown beetle, in addition to the larvae of the Pyralid moths, *Mussidia nigrivenella*, Rag., and *Ephestia cautella*, Walk., and all these pests reappeared in great force in the new maize almost as soon as it was stored. None of the field pests other than these was found to attack stored maize.

As showing the remarkable instinct possessed by these pests for finding food for themselves and their offspring it may be mentioned that, in early November, five sacks of sound maize, apparently free from insects, were placed in the laboratory. On the following day maize beetles and moths were observed to be flying in at the windows, at once settling on the sacks, and there was a gradual and constant invasion subsequently, so that at the end of December the grain was absolutely riddled by them. A large number of little Chalcids were then discovered in the maize and it was subsequently found that they were breeding freely in larvae of *Calandra*, though owing to the enormous numbers of these beetles they were not effective as a check. These parasites belong to a new species of *Meraporus* (family Pteromalidae) which will shortly be described by Mr. James Waterston.

The harvested grain was placed in a seed store, the window frames of which were filled with copper mosquito gauze for ventilation purposes. In March, a dense mass of the moths *Ephestia* and *Mussidia* could be seen early each morning flying up and down on the outside in an endeavour to find an entrance, and settling down quietly

as the day advanced to wait till night-fall before resuming their activities, eventually dying in such numbers that handfuls could be gathered on each sill.

With a view to estimating the relative increase of, and the damage done by, *Calandra* and *Tribolium* respectively, the following experiments were conducted. On 27th October, half a pound of thoroughly sun-dried new maize was placed in a well closed glass jar with fifty *Calandra*. When examined again on 30th December, the maize, shaken free of debris produced by the attack, was found to have lost $1\frac{1}{2}$ oz. in weight, and though only 40 per cent. of the seeds had been attacked, 420 weevils and a large number of larvae were found.

On the same day half a pound of maize was placed in a sealed jar with 50 *Tribolium*. On 30th December the grain, shaken free of debris, had lost 2 oz. in weight, and though the beetles, exclusive of larvae, had only increased to 167, the grain had suffered to the extent of about 65 per cent., a much greater damage therefore than in the first experiment. The explanation of this appears to be that *Tribolium* bores into a grain, deposits an egg or feeds, and then goes on to another grain, whereas *Calandra* will contentedly feed away and oviposit in a single grain. It was found in the laboratory that a single grain of maize contains sufficient nourishment to support a female *Calandra* and her developing offspring for five weeks, at the end of which time her mature offspring may number five or six, all of which have fed up on this one grain. These results were not obtained in the case of *Tribolium*, though in one case a single mature insect was bred out in the course of a month from one grain, which also supported the female parent during this time.

Further experiments show that, though both *Calandra* and *Tribolium* are found in cobs in the field, yet *Calandra* does not seem to have the power, possessed by *Tribolium*, of boring through the unbroken sheath of the cob. *Calandra* placed on such a sheath in glass tubes, mouth downwards, died a lingering death after ten to fifteen days without having pierced it, whereas *Tribolium* very soon disappeared into the cob. In all probability, therefore, *Calandra* obtains access to the cob through the opening at the apex from which the silk has dropped out, or through holes made in the sheath by borers.

A few experiments were made in the hope of finding if possible a sacking material proof against *Calandra* and *Tribolium* for the storage of fumigated maize, but the only fact established was that the weevil does not penetrate a coarse drill, though unfortunately *Tribolium* has no difficulty in doing so.

As has been already noted, the Pyralid moth, *Mussidia*, is a formidable pest in stored maize. The larva when first hatched bores into a grain and eats out the soft nitrogenous radicle at the apex, leaving the harder part untouched, so that a grain attacked comes to resemble in shape a small double tooth with two fang-like processes. When this is finished, if the grain is still on the cob, it gradually tunnels along the whole length of a row, eating away the softer portions and leaving the hard shells, and it pupates eventually in a silken cocoon in this tunnel. There is often no surface evidence of the damage which is proceeding.

When shelled maize is attacked the caterpillar spins grains together and then bores through the mass. Silk web with characteristic damage is to be looked on as infallible evidence as to the presence of this moth. A rough estimate of the damage done by the pest was obtained by placing, on 30th October, four female moths in a jar

containing 8 oz. of sound maize. Oviposition took place at once and a few days later a large number of larvae hatched out. At the end of two months, on 30th December, two generations had completed their life-cycle; the maize, shaken free of debris, had lost 25 per cent. in weight, and 50 per cent. of the grain showed evidence of attack. For the purpose of freeing the seed maize at Moor Plantation from these insect pests, it was fumigated, after preliminary experiments, with carbon bisulphide, employed as suggested by the Imperial Institute, at the rate of 5 lb. per 1,000 cubic feet of space, and fumigation of each batch was made to extend over five days, by which time it was anticipated that, even if the eggs of the pest had not been killed, the larvae would have hatched out and perished.

These anticipations seemed at first to be fully realized and for some time there were no signs of living pests. But at the end of about three months, greatly to my surprise and disappointment, weevils and grain beetles reappeared in some of the sacks. I then made a careful examination of the fumigating bins, and discovered defects both of construction and of material by which the success of the fumigation might have been vitiated. Moreover, on turning my attention to the store itself, I found numerous slits in the boarding of the roof, by which any number of insect pests might subsequently have entered. As a result, the pests increased to such an extent that further fumigation was urgently called for. Unfortunately the double fumigation affected the germinating powers of most of the seed, but I am confident that if the operation could be carried out under favourable conditions in properly constructed receptacles, and if the grain were kept subsequently in a well-made store, adequately ventilated, a single fumigation of the strength recommended would suffice to exterminate entirely all forms of the pests.

At the suggestion of Mr. A. H. Kirby, the Assistant Director of Agriculture, and in collaboration with him, experiments were made as to the value of the fumigation of grain against insect pests with carbon dioxide. In default of more suitable apparatus, kerosene tins were filled with infested grain and carbon dioxide was driven in, the tins being then sealed. At the end of ten days the tins were ventilated and again sealed. The results were entirely satisfactory, no living pests being found months later, and the germination percentage being very high. I wish to take this opportunity of thanking Mr. Kirby for his very valuable suggestion.

When tried on a larger scale in one of the bins the results were not so good, but I subsequently found a large crack in the floor by which the gas doubtless leaked out prematurely.

Insect Pests of Rubber.

Para rubber plants were singularly free from insect attack, the only leaf-eater found being the omnivorous grasshopper, *Zonocerus variegatus*, which attacked young nursery plants, those that were not well shaded being far more damaged by these sun-loving pests than those which were more sheltered.

The large cricket, *Brachytrypes membranaceus*, Drury, which sometimes fed on the roots of young plants, was responsible for a slight loss, but it was preyed on by the fossorial wasp, *Chlorion xanthoceros*, Illig., var. *instabilis*, Sm., which thus acts as a valuable natural check.

Funtumia elastica is attacked by two Lepidopterous leaf-eaters, the larva of a species of Sphingid moth of the genus *Nephele*, which is much parasitised by Braconids,

and the larva of the Pyralid leaf-roller, *Glyphodes ocellata*, Hmp., which is found especially on young plants.

A borer, probably a beetle larva, is found occasionally at work towards the base of trees, tunnelling under the bark and causing an exudation of latex.

Funtumia pods, when open, were found to contain a variety of insect pests. The larvae of the Pyralid moth, *Entephria sexpunctalis*, Hmp., were found tunneling whole rows of the seeds close to their attachment to the placenta, and the little beetles *Berginus tamaricis*, Woll., occurred in some numbers feeding on the seeds. Some of the pods were filled with almost incredible numbers of the Lygaeid bug, *Arocatus continctus*, Dist.,* the larvae of which were feeding on the seeds, the imagos being found in immense swarms under the leaves.

Insects Attacking Ground-nuts.

These were fairly free from insect pests, the only leaf-eater found being the larva of the Psychid moth, *Metisa sierricola*, White, mentioned under cacao (Plate xxiii). The scale-insect, *Ceronema africana*, Macfie, was found abundantly on a few plants (Plate xxiii).

Insects Attacking Beans.

Young plants in July were much attacked by various species of beetles. Of these the Lagriids, *Lagria villosa*, F., and *L. viridipennis*, F., were responsible for large irregular holes in the leaves, while the Galerucid, *Ootheca mutabilis*, Sahlb., seemed to limit its attention to the young shoots, eating half through the stem so that withering took place.

As this crop is grown in Nigeria only as green manure, and as Leguminous plants stand the action of insecticides badly, it was thought undesirable to use the spray on them, and so boys were instructed in the art of collecting the pests by means of light sweep nets, a method which was found to work satisfactorily. As showing the abundance of the pests it may be mentioned that 797 were obtained in two days by two small boys in this way.

In early December, the height of the dry season, the two Lagriid beetles were found in great numbers, aestivating in the axils of a Bromeliaceous plant. In the store the bean seeds were to some extent attacked by an undetermined beetle of the genus *Bruchus*.

Pests of Pigeon Pea.

Though this plant is of small economic importance in Nigeria, being grown only for the purpose of shading young cacao, it is of considerable importance as a food-plant in the East, and thus some study of the pests attacking it in Nigeria has seemed desirable. Moreover, as will be seen, several of the insects found on it are also injurious to cacao.

The scale-insect, *Cerônema africana*, found also on ground-nut plants, was abundant (Plate xxiv, fig. 2). The *Pseudococcus* found on cacao (Plate xxi, fig. 2) was to be found here and there and another cacao scale, *Stictococcus dimorphus*, Newst. (Plate xxii), was very numerous. A species of *Icerya* (Plate xxiv, fig. 1) was also found from time to time. Leaf-eaters of many kinds were found and the seed also was attacked

* For a figure of this species see p. 242.

by various larvae, the chief of which were the larva of the Pterophorid moth, *Marasmarcha atomosa*, Wlsm., that often yielded Braconid parasites, and the larva of the Lycaenid butterfly, *Lampides boetica*, L., The latter, of the usual green onisciform type, was guarded by various ants, *Camponotus akwapimensis* in particular, a group of which at the mouth of a tunnel in one of the pods invariably indicated the presence of the larva within. Larvae of another undetermined moth were also not uncommon, boring in the pods.

The gregarious froghopper, *Ptyelus grossus*, F., occurred both in the nymphal and imaginal states, feeding on the stems, which were so drained that frequently a constant stream of fluid trickled to the ground.

Insects Attacking Oil Palms.

A little weevil (*Calandra oryzae*, L.) was found in some numbers boring in an oil palm scorched by repeated bush fires. Evidence that it had reached living tissues was shown by the constant dripping of sap, which attracted a host of other insects, ants especially, but few of the pests could be obtained owing to the difficulty of getting them out of the hard tissues in which they had embedded themselves.

No other pests attacking oil palm were found in Nigeria, but it may be mentioned, in passing, that in the course of some entomological investigations on my way home, in late May, in Cotonou, Dahomey, weevils in almost incredible numbers were found feeding on the fresh male flowers of the palm, hundreds being taken in a few minutes.*

Pests of Sweet Potato.

No pests were found in the field other than the larva of the convolvulus hawkmoth, *Herse convolvuli*, L., which fed on the leaves. The tubers in the store were considerably attacked by two species of weevils, *Cylas brunneus*, F., and *C. puncticollis*, Boh., all stages of which could be found in cavities in the substance (Plate xxv, fig. 1).

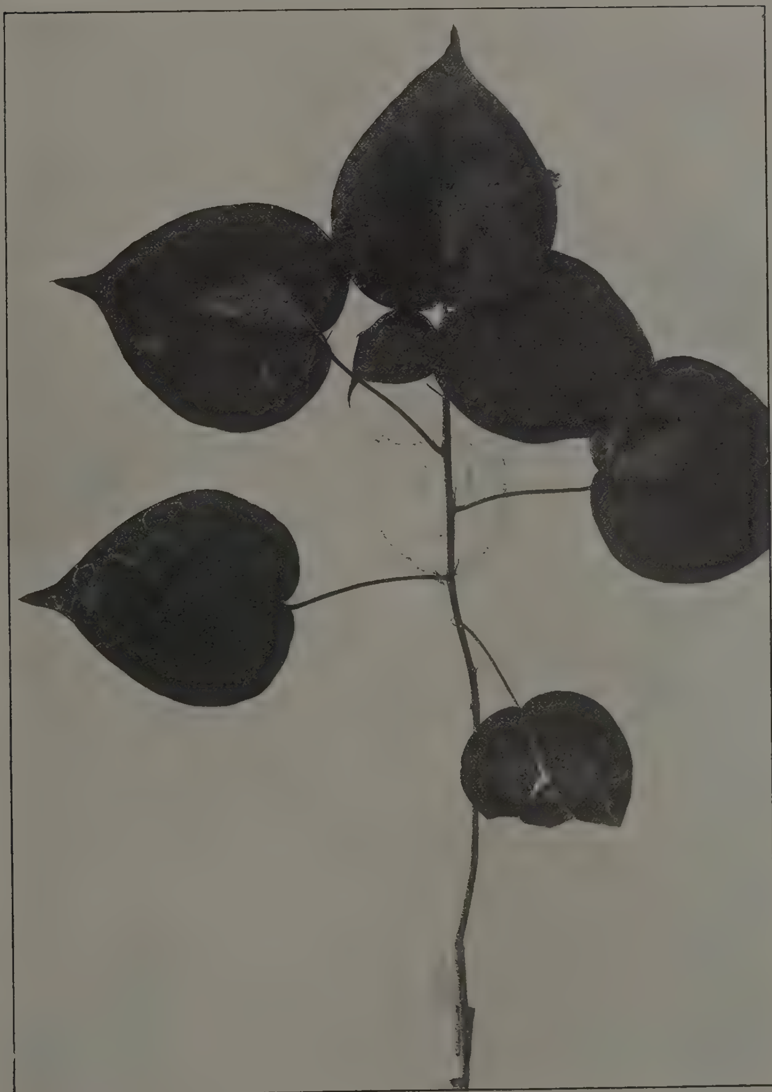
My thanks are due to Mr. G. A. K. Marshall, Director of the Imperial Bureau of Entomology, for editing the proofs of these notes and for obtaining for me the identification of the majority of the insects mentioned. For the identification of most of the Lepidoptera I am indebted to Professor E. B. Poulton, F.R.S.

*[These weevils all belong to the genus *Derelomus*, there being no less than four species among them. The most abundant was *D. kamerunicus*, Fst., and the remaining three species appear to be undescribed.—Ed.]

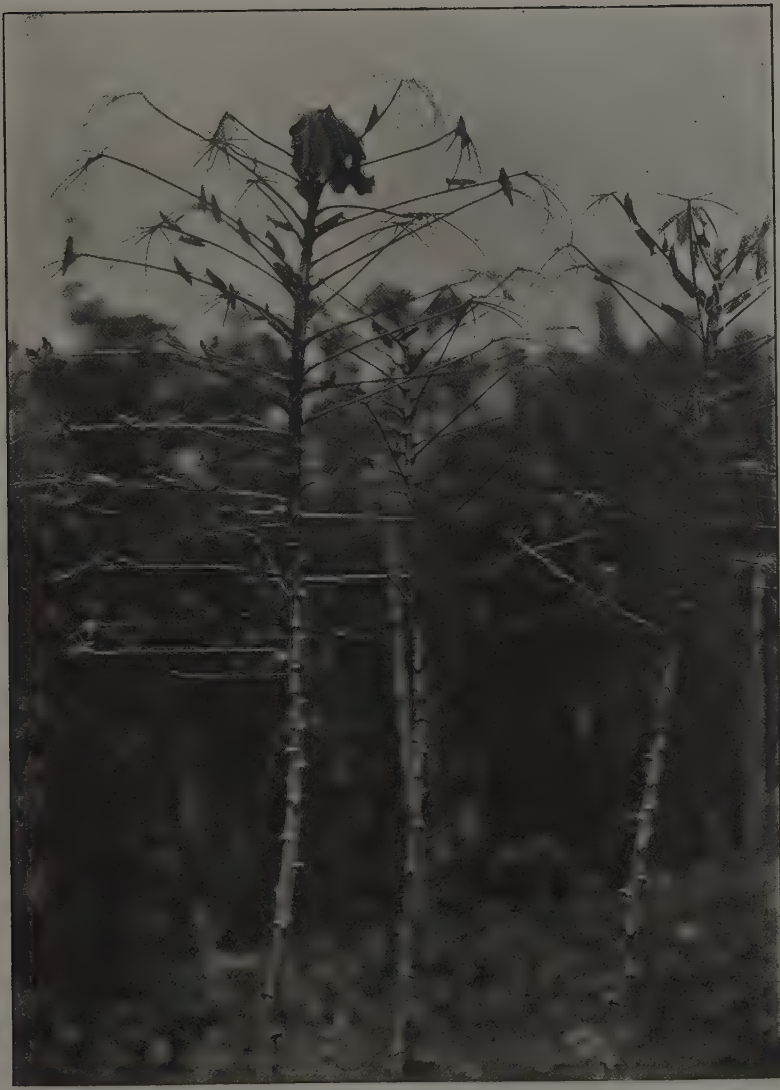
Explanation of Plate XVII.

Fig. 1. *Sesamia calamistis*, Hmp., p. 209.
2. *Eldana saccharina*, Walk., p. 209.
3. *Busseola fusca*, Hmp., p. 209.
4. *Metadrepana glauca*, Hmp., p. 208.
5. *Mussidia nigrivenella*, Rag., p. 209.
6. *Characoma stictigrapta*, Hmp., p. 206.
7. *Eulophonotus myrmeleon*, Feld., ♂, p. 204.
8. *Duomitus armstrongi*, Hmp., p. 245.
9. *Eulophonotus myrmeleon*, Feld., ♀, p. 204.
10. *Acrocercops bifasciata*, Wlsm., p. 197.

INJURIOUS WEST AFRICAN MOTHS.



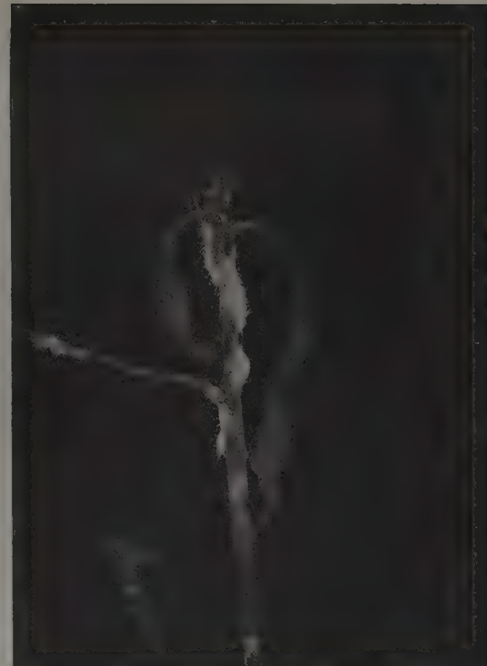
Young Cotton Plant, showing Mines of *Acrocercops bifasciata*, Wlsm.



Cassava Plants defoliated by Locusts (*Zonocerus variegatus*, L.)

Effects produced on young Cotton Plants by a Buprestid Stem-borer,
Pseudagrilus sophoræ, L.

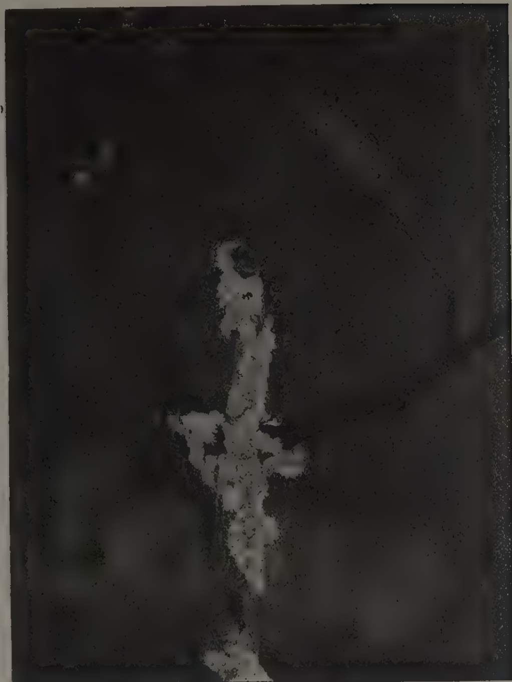
1
Pulvinaria jacksoni, Newst., on Cotton.



2
Dactylopius on Cacao.

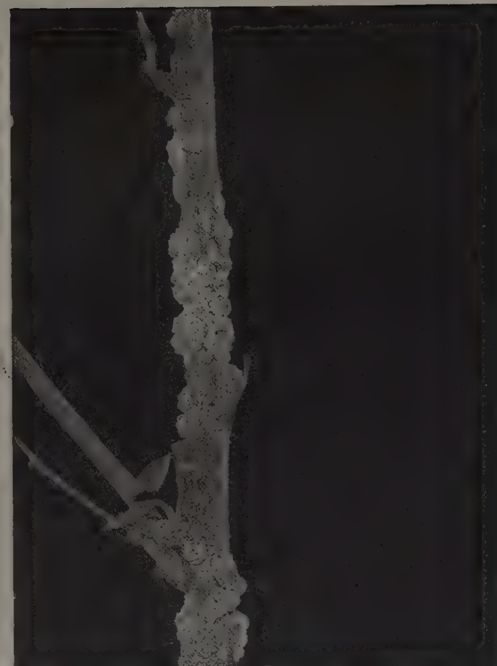
Cacao Pods infested with Scale-Insects (*Stictococcus dimorphus*, Newst.) which are being attended by Ants (*Oecophylla*).

Ground-nuts (*Arachis*) attacked by Scale-Insects (*Ceronema africana*, Macfie); at the top of the figure is a female Psychid Moth (*Metisa sierricola*, White) in its case, paired with a male.



1

Icerya sp., a Cacao and Pigeon Pea Scale.

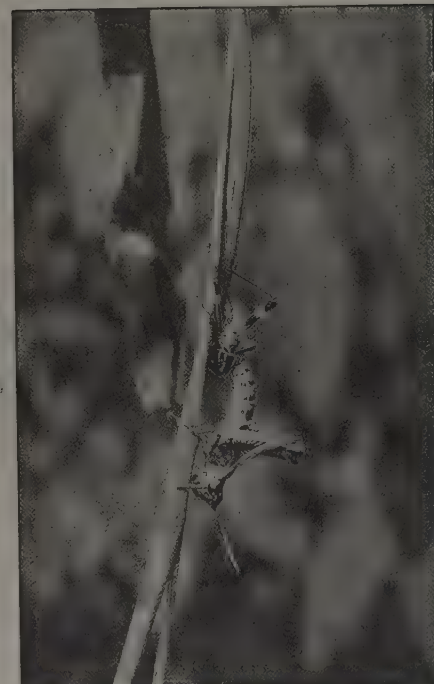


2

Ceronema africana, Macfie, on Pigeon Pea.

1

Sweet Potato attacked by *Cylas* weevils.



2

Final Ecdysis of *Zonocerus variegatus*.

ON THE PARASITIC ACARI FOUND ON THE SPECIES OF RODENTS FREQUENTING HUMAN HABITATIONS IN EGYPT.

By Stanley Hirst.

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The Acari dealt with in this paper were collected by Dr. G. F. Petrie during his plague investigations in Egypt. My best thanks are due to him and also to the authorities of the Lister Institute for their kindness in permitting me to examine this collection.

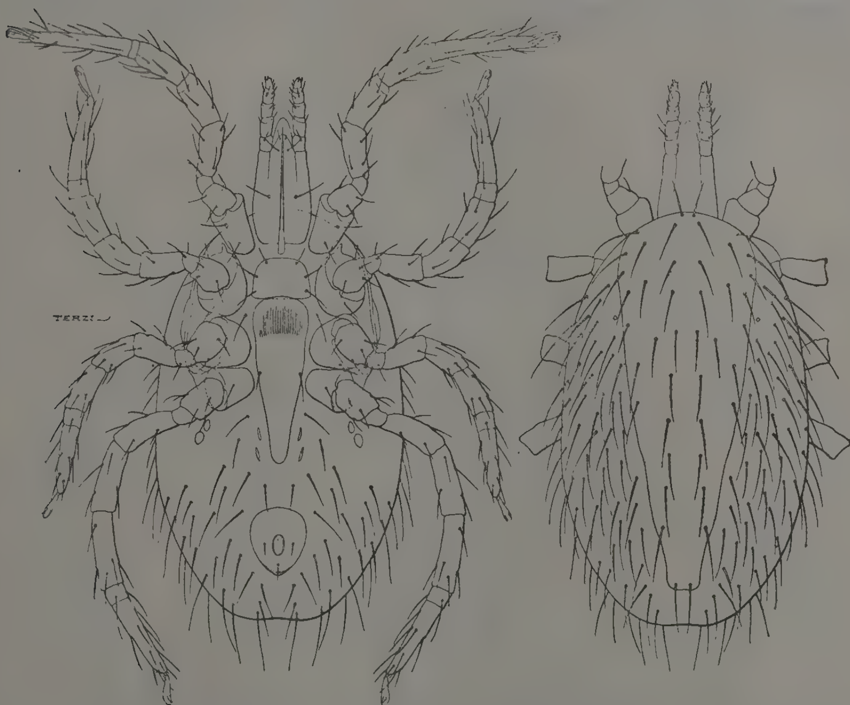

Fig. 1. *Dermanyssus muris*, Hirst, ♀; ventral and dorsal aspects.

The species are few in number, but several of them are represented by very numerous specimens, including developmental stages of considerable importance. Three of them (*Dermanyssus muris*, *Leiognathus bacoti*, and *Laelaps echidninus*) are very widely distributed forms and it seems probable that rats (*Mus rattus* and *M. norvegicus*) are their principal hosts. *L. bacoti* is of exceptional interest, owing to the fact that it readily attacks man.

Family Gamasidae.

1. Dermanyssus muris, Hirst (figs. 1–4).

Dermanyssus (*Liponyssoides*) *muris*, Hirst, Bull. Ent. Res. iv, pp. 120–122, text-figs. 1 and 2 (1913).

♀. *Dorsal shield* and *anal plate* shaped very like those of *D. gallinae*, Redi, but the shield has long hairs on its surface instead of short ones. *Sternal plate* trapezoidal in shape and furnished with three pairs of long fine hairs. *Genito-ventral plate* much narrower, especially posteriorly, than is the case in *D. gallinae*; on either side of and parallel with this plate, there are two very narrow (linear) platelets, which are not very easy to see. A pair of little oval platelets are also present behind each of the fourth coxae. *Peritreme* long, seemingly extending as far forwards as or slightly beyond the coxa of the second leg. Anterior surface of coxa of *second leg* armed dorsally with a sharp forwardly directed spur. *Length* of body (gorged specimen), 1·87 mm.

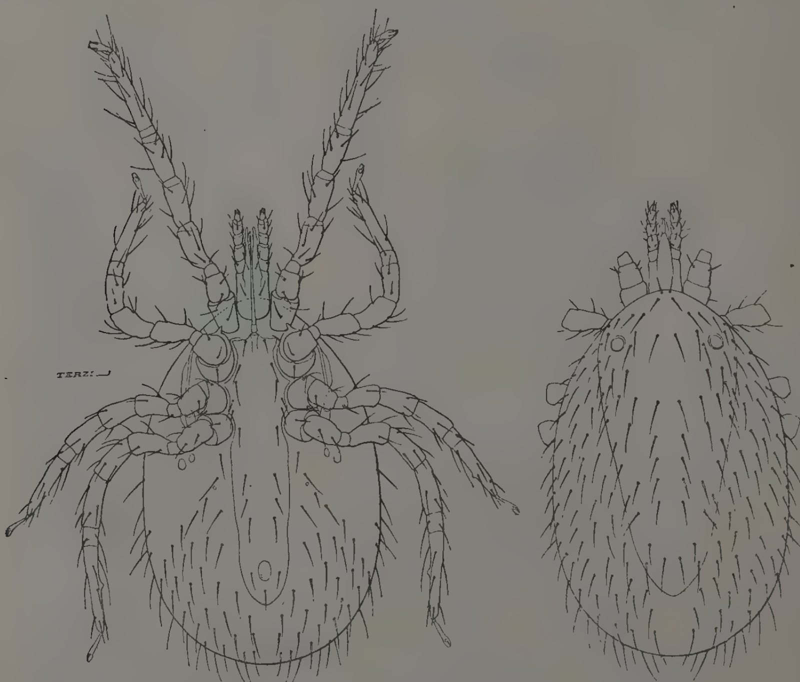

Fig. 2. *Dermanyssus muris*, Hirst, ♂; ventral and dorsal aspects.

♂. *Dorsal shield* long and fairly wide, the posterior end being rounded (occasionally somewhat angular) instead of subtruncate as in the female; at some distance from the anterior end of this shield, there is a pair of rather large eye-like organs on its surface and they are widely separated from one another, being placed close to the

lateral margins. *Sterno-ventral plate* practically uniform in width posteriorly, the sides being almost straight; it bears ten pairs of hairs and a single unpaired posterior hair on its surface. Behind each of the coxae of the last pair of legs there is a pair of platelets. *Peritreme* very long, apparently extending beyond the first coxa. *Chelicera* fairly long; apparently the digits are fused together and they are accompanied by a free slender process or flagellum, which is as long as the digits themselves and furnished with a sharp little tooth. *Legs.* Anterior surface of coxa of second leg armed with a tooth as in the female. Tarsi of third and fourth legs long and slender; there is a little conical protuberance near the middle of the ventral surface of the distal part of these tarsi.

Length of body, ·95 mm.

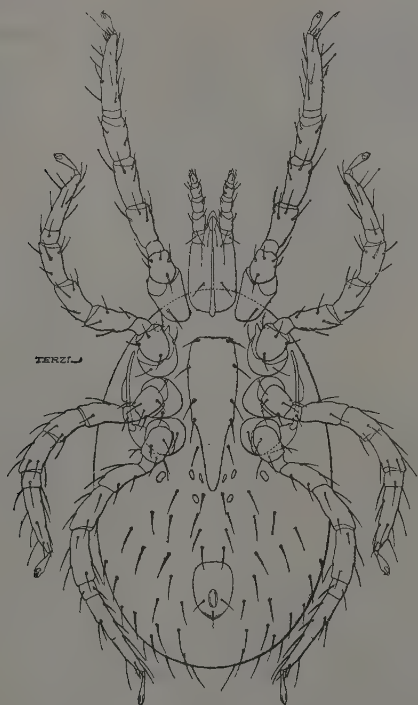

Fig. 3. *Dermanyssus muris*, Hirst; ventral view of deutonymph.

*Deutonymph.** *Dorsal shield* closely resembling that of the female. On the side of the body above the proximal segments of the second leg there is a small but distinct oval plate. *Sternal plate* long; its posterior end is bluntly pointed and projects well beyond the last coxae, four (sometimes five?) pairs of hairs are present on it; on each side of the posterior end of this plate, there are three minute platelets, but they are inconspicuous. A distinct bilobed platelet is also present

* The deutonymph described above, and also those of the two other species of *Dermanyssus* described in this report, are probably females.

behind each of the coxae of the last pair of legs. *Peritreme* extending forwards as far as the middle of the second coxa or slightly further. Anterior surface of coxa of second leg with a well-developed spur as in the adult female. *Length* of body, 1 mm.

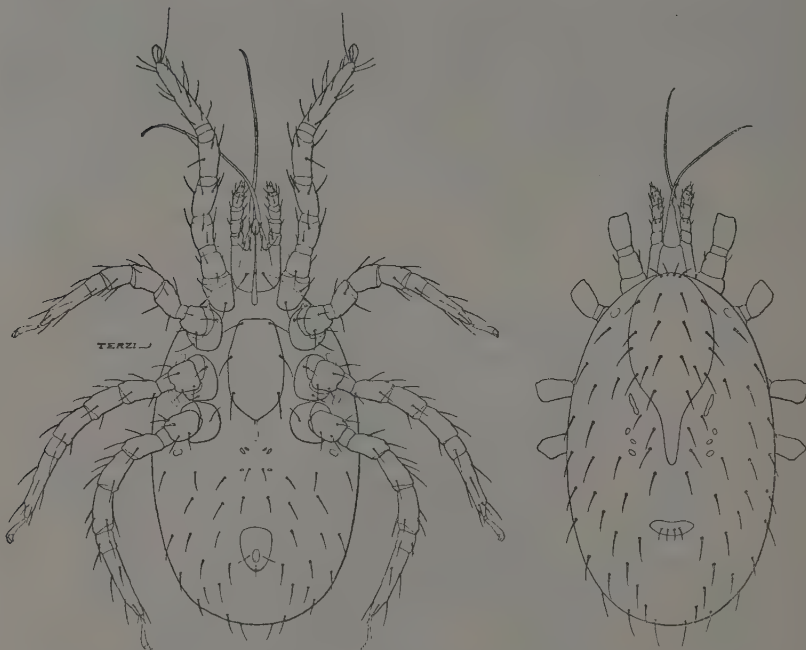

Fig. 4. *Dermanyssus muris,* Hirst; ventral and dorsal aspects of protonymph.

Protonymph. Principal *dorsal shield* very different in shape from that of the female and deutonymph. It is fairly large and rather wide, but has a narrow tail-like prolongation posteriorly; hairs on its surface long, fine and not very numerous. Four minute and inconspicuous *platelets* are present on each side of the tail-like portion of it, those of the anterior pair being narrow and elongated, but those of the other three pairs much smaller and oval in shape. A rather small but distinct *posterior dorsal shield,* which is transversely elongated and somewhat recurved, is also present and bears 2–4 hairs. A little subcircular platelet is situated on the side of the body above the interval between the first and second legs and another very similar, but almost ovate, platelet is situated slightly in advance of the anterior end of the peritreme. *Sternal plate* fairly wide and reaching backwards to about the middle of the last coxae; it has three pairs of long fine hairs on it. There are three pairs of very minute and inconspicuous platelets posterior to the sternal plate and a distinct bilobed platelet behind each of the last coxae. *Peritreme* very short. Anterior surface of coxa of second leg armed with a small but distinct spur. *Length* of body, ·72 mm.

The female, male and protonymph are described from both Oriental and Egyptian specimens, but the account of the deutonymph is based entirely on Egyptian material.

EGYPT: Assiût, specimens were on the following hosts:—(1) Several hundred specimens from *Mus rattus*, both in the town and on the feluccas; (2) one specimen found on *Mus norvegicus*; (3) a few specimens from *Arvicanthis niloticus* (in houses). Kous; a few specimens found on *Mus rattus* and one on *Acomys*. El Hasaiba, Deirût; seven specimens found on *Mus rattus*.

ARABIA: Sheik Othman; one specimen on a rat (species not determined) collected by Dr. Macrae and now in the collection of Mr. James Waterston.

INDIA: Madras, on *Mus rattus*.

CEYLON: Colombo, on *Mus rattus*.

2. Dermanyssus sanguineus, sp. nov. (figs. 5–8).

♀. Dorsal surface with two distinct *shields*, the posterior one being of small size. *Anterior dorsal shield* of moderate length and rather wide at the anterior end but

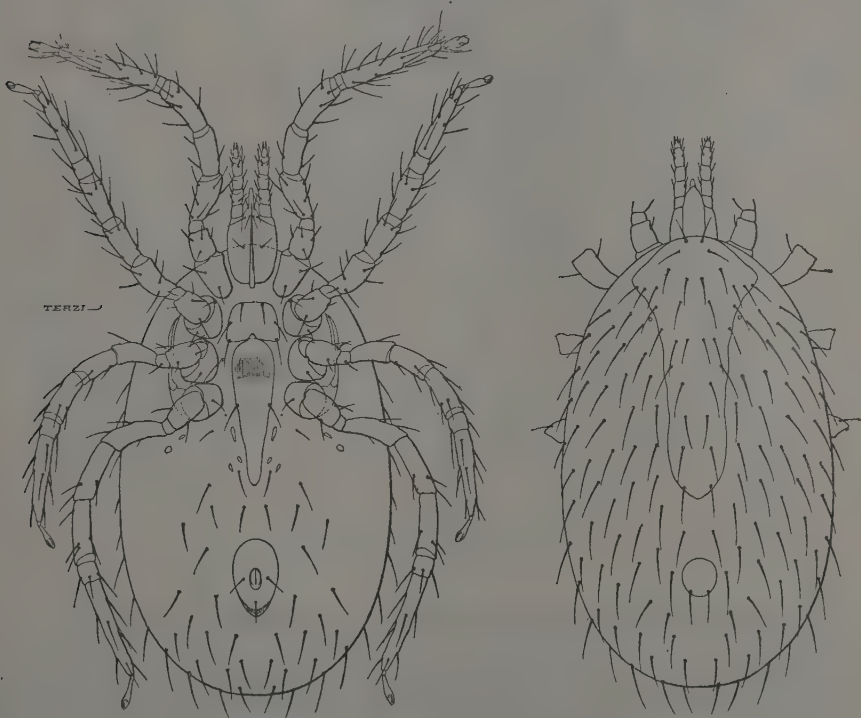

Fig. 5. *Dermanyssus sanguineus*, ♀; ventral and dorsal aspects.

narrower posteriorly, ending abruptly, the posterior extremity being fairly wide and somewhat rounded; hairs on this shield fairly long. *Posterior dorsal shield* almost ovate in shape and always furnished with a pair of fairly long hairs. *Sternal plate*

practically trapezoidal in shape; although considerably wider than long, its length is much greater as compared with the width than is the case in *D. aegyptius*; there are three pairs of hairs on its surface. *Genito-ventral plate* narrow and long, extending backwards far beyond the last coxae. There are three inconspicuous platelets on each side of this plate, those of the anterior pair being elongated. *Anal plate* long oval in shape, as in *D. aegyptius*. Two minute platelets are present posterior to (and somewhat to the side of) each of the coxae of the fourth legs. *Peritreme* extending as far forwards as or slightly beyond the middle of the coxa of the second leg. Anterior surface of coxa of *second leg* without a spur. *Length* of body of distended specimen, 1·4 mm.

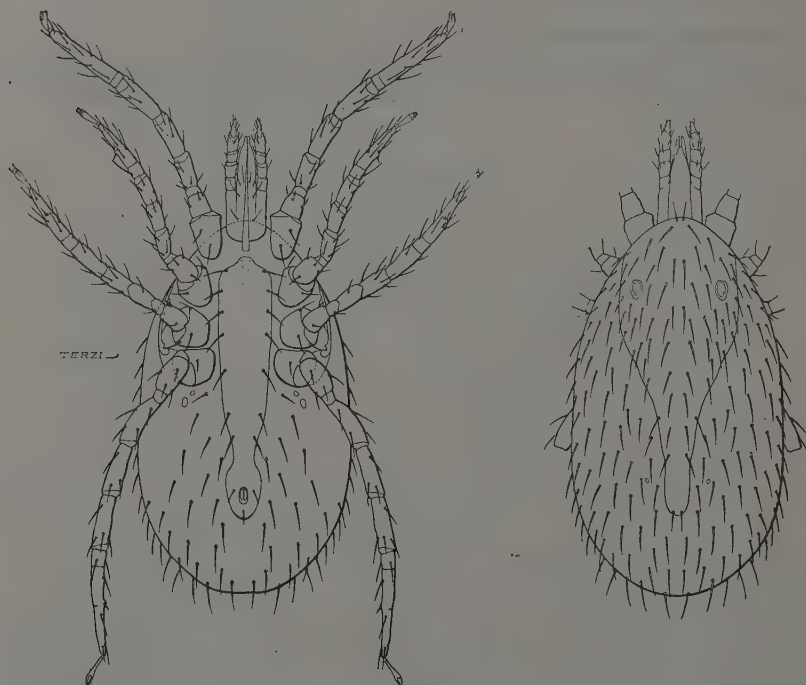

Fig. 6. *Dermanyssus sanguineus*, Hirst, ♂; ventral and dorsal aspects.

♂. *Dorsal shield* wide anteriorly but progressively narrowed posteriorly, the terminal part of it being quite narrow and the extreme end blunt; a number of hairs of moderate length are present on this shield, including a pair at the posterior end. A pair of structures somewhat resembling the eye-like structures of *D. muris* are present in the same position on the dorsal shield, but they are irregular in shape and much less conspicuous. *Sterno-ventral plate* with the sides not so straight as in *D. muris*, and narrowed so as to form a distinct neck in front of the slightly

enlarged anal portion; eight pairs of hairs and the usual unpaired posterior hair are present on this plate. *Peritreme* rather short, apparently not reaching as far forwards as the middle of the second coxa (?), but its supporting plate proceeds a little further forwards. Tarsi of third and fourth legs long and slender; the conical projection on their ventral surface is situated in practically the same position as in *D. muris*. *Chelicera* closely resembling that of *D. muris*, a long accessory flagellum being present. *Length* of body, ·7 mm.

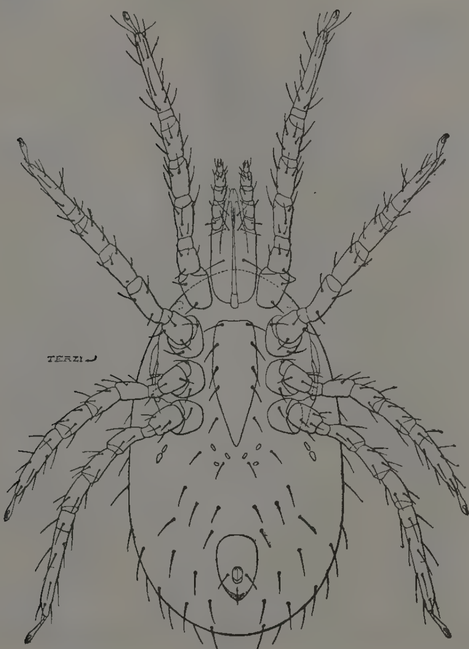

Fig. 7. Ventral view of deutonymph of *Dermanyssus sanguineus*, Hirst.

Deutonymph. *Dorsal shields* very similar to those of the female. A small circular or sub-circular platelet is situated above the interval between the first and second legs. *Sternal plate* projecting backwards well beyond the last coxae and its end rather sharply pointed; it has four pairs of hairs on it. Immediately behind the sternal plate, there are three pairs of very minute and inconspicuous platelets. A pair of platelets placed close together are also present just behind each of the last coxae. *Peritreme* short, the tubular part of it, apparently, only reaching a little in front of the third coxa, but it is continued forwards by its chitinous shield, which almost reaches the middle of the second coxa. *Length* of body, ·7 mm.

Protonymph. Principal *dorsal shield* very like that of the same stage of *D. muris.* Four pairs of minute lateral platelets very similar in appearance to those present in *D. muris* can also be made out, but the posterior ones are very minute and difficult to see. The small *posterior shield* bearing two hairs is not quite so elongated as in the female or deutonymph. *Sternal shield* about as long as that of the protonymph of *D. muris*, but with only three pairs of hairs. *Peritreme* very short. *Length* of body, ·52 mm.

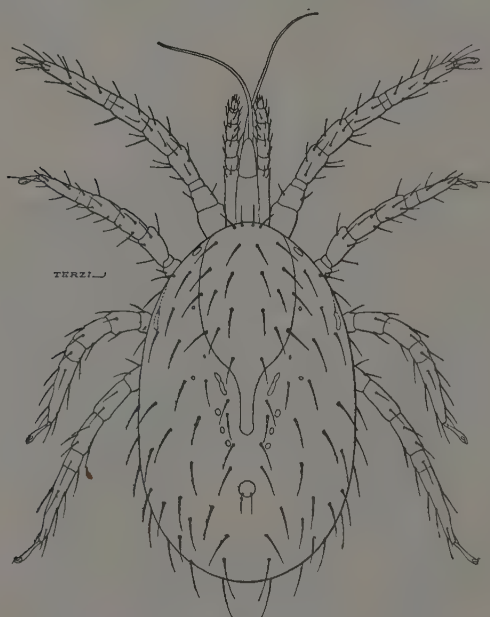

Fig. 8. Dorsal view of protonymph of *Dermanyssus sanguineus*, Hirst.

EGYPT: Assiût: (1) Numerous specimens found on *Mus rattus* in the town and a few on the same host on the feluccas there; (2) ten specimens from *Arvicanthis niloticus* (in houses); (3) one specimen from *Acomys cahirinus*. El Hasaiba, Deirût; twelve specimens from *Mus rattus*. Kous; three specimens from *Mus rattus*.

3. Dermanyssus aegyptius, Hirst (figs. 9–11).

Dermanyssus (*Liponyssoides*) *aegyptius*, Hirst, Bull. Ent. Res. iv, p. 122 (1913).

♀. Two shields are present on the dorsal surface as in *D. sanguineus*, sp. n., but the posterior one is minute and inconspicuous. *Anterior dorsal shield* long and narrow; posteriorly it is very much reduced in width, being practically linear (this part of the scutum is shown a little too wide in fig. 9), but the extreme end is very slightly enlarged again; hairs on this shield fairly long. Two minute and very narrow

(linear) platelets can sometimes be distinguished on each side of this shield, but they are difficult to see. *Posterior dorsal shield* minute and without any hairs on its surface; its outline presents a close resemblance to a butterfly, four lobes or wings being visible. *Sternal plate* very much wider than long and with only two pairs of hairs; immediately behind it, however, there is a pair of small but distinct platelets, each of which bears a very long fine hair similar to those on the sternal plate. *Genito-ventral plate* narrow and long, projecting far beyond the last coxae, and its posterior

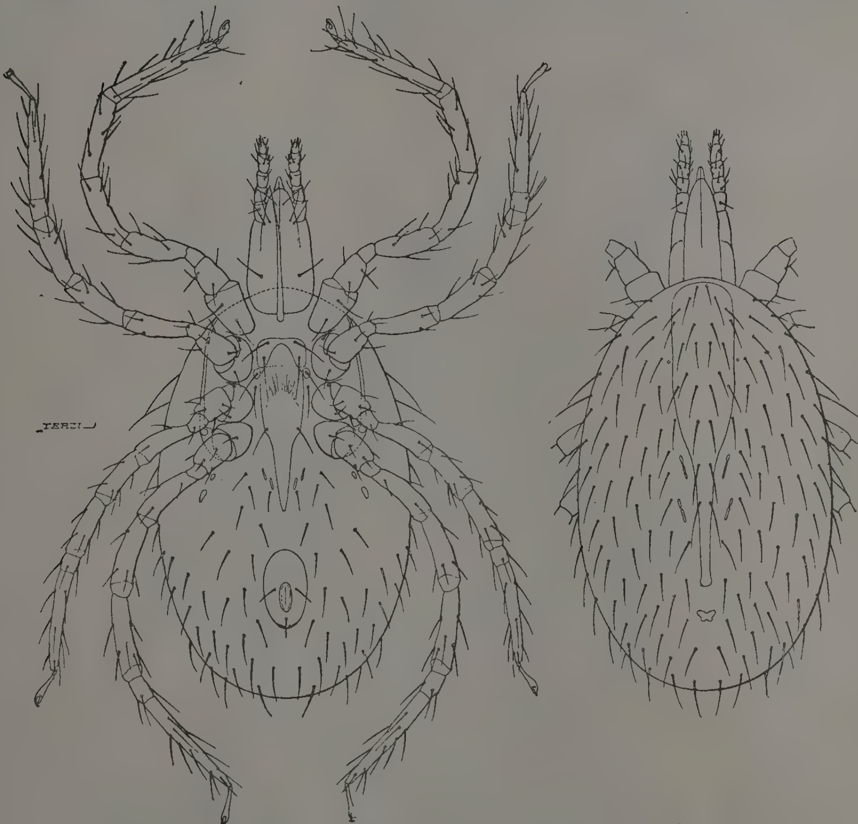

Fig. 9. *Dermanyssus aegyptius*, Hirst, ♀; ventral and dorsal aspects.

end sharply pointed; it is furnished with the usual pair of hairs. On each side of this plate there are two very narrow elongated platelets as in *D. muris*, but they are very inconspicuous. There is also a pair of platelets behind each of the coxae of the last pair of legs. *Anal plate* long oval in shape. *Peritreme* extending about as as far forwards as the middle of the coxa of the second leg. *Legs* more slender than is the case in *D. muris*. Anterior surface of coxa of second leg without a spur. *Length* of body (gorged specimen), 1·9 mm.

Deutonymph. Dorsal shields both closely resembling those of the female. Two or three platelets are situated on each side of the anterior shield. A small but distinct platelet is placed above the interval between the first and second legs and it is narrow and elongated instead of being oval as in the deutonymph of *D. muris*. *Sternal plate* projecting backwards distinctly beyond the last coxae; three pairs of hairs are present on it. *Peritreme* rather short, and apparently not reaching as far as the middle of the second coxa. *Length* of body, 1·1 mm.

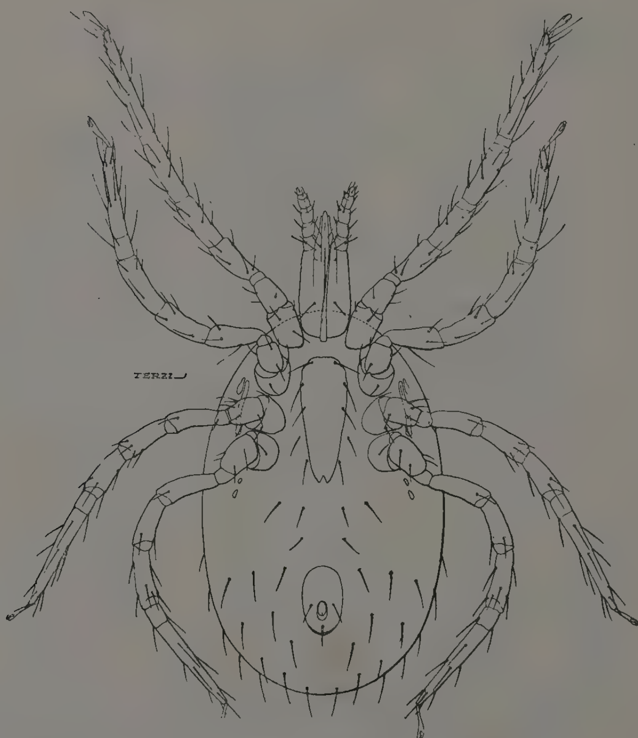

Fig. 10. Ventral view of deutonymph of *Dermanyssus aegyptius*, Hirst.

Protonymph. Dorsal shields very like those of the adult and deutonymph; the posterior tail-like prolongation of the main shield is much narrower than is the case in the protonymphs of *D. muris* and *D. sanguineus*; four minute platelets are situated on each side of this part of the shield, those of the two anterior pairs being elongated, but the posterior ones are oval and they are very minute and inconspicuous. There are two little platelets on the side of the body; the anterior one is situated as in the deutonymph, and the other is in front of the anterior end of the peritreme. *Sternal plate* extending backwards beyond the middle of the last

coxae and furnished with three pairs of hairs. A minute platelet is situated behind each of the coxae of the last pair of legs. *Peritreme* very short. *Length* of body, ·61–·7 mm.

EGYPT: Assiût; specimens found on the following hosts:—(1) Over three hundred specimens taken on *Acomys cahirinus* in the town and a few on the feluccas; (2) a large number of specimens on *Mus rattus* in the town and a few on the feluccas; (3) three specimens from *Mus norvegicus* (on feluccas); (4) *Arvicanthis niloticus* (in houses), eight specimens. El Weladie; thirteen specimens (name of host not given). Kous; a few specimens found on *Acomys cahirinus*.

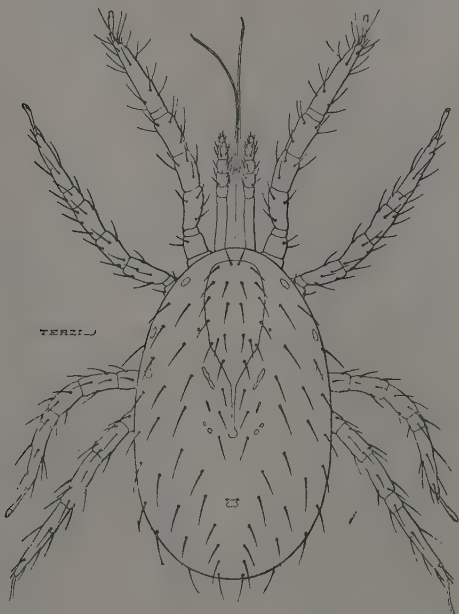

Fig. 11. Dorsal view of protonymph of *Dermanyssus aegyptius*, Hirst.

4. Leiognathus bacoti, Hirst (figs. 12–14).

Leiognathus bacoti, Hirst, Bull. Ent. Res. iv, p. 122 (1913).

♀. The original description of the female of this species is fairly complete and therefore only a few additional details are given here:—Two elongated *platelets* are placed symmetrically on each side of the genito-ventral plate. Anterior surface of coxa of first leg with the upper angle projecting and dentiform. Anterior surface of coxa of second leg armed distally with a distinct spine, but, owing to its position, this spine is not always easy to see. *Peritreme* reaching far forwards; its supporting plate ends anteriorly in a lancet-shaped expansion situated on the dorso-lateral surface of the body above the interval between the first and second coxae. (The

tubular part of the peritreme appears to vary in length in mounted preparations of this and other Gamasid mites, but I think that this is merely due to the fact that this tube can only be readily seen for its full length when filled throughout with air.) *Length* of body (distended specimen), ·95 mm.

♂. *Dorsal shield* almost as wide and long as the body, but leaving a narrow lateral strip of unprotected integument (except anteriorly); hairs on its dorsal surface rather long and fine; a longitudinal series of paired hairs runs down the middle, those of the last pair being placed close together at the end; there are a few other symmetrically arranged hairs near the middle and also a lateral series. *Sternal plate*

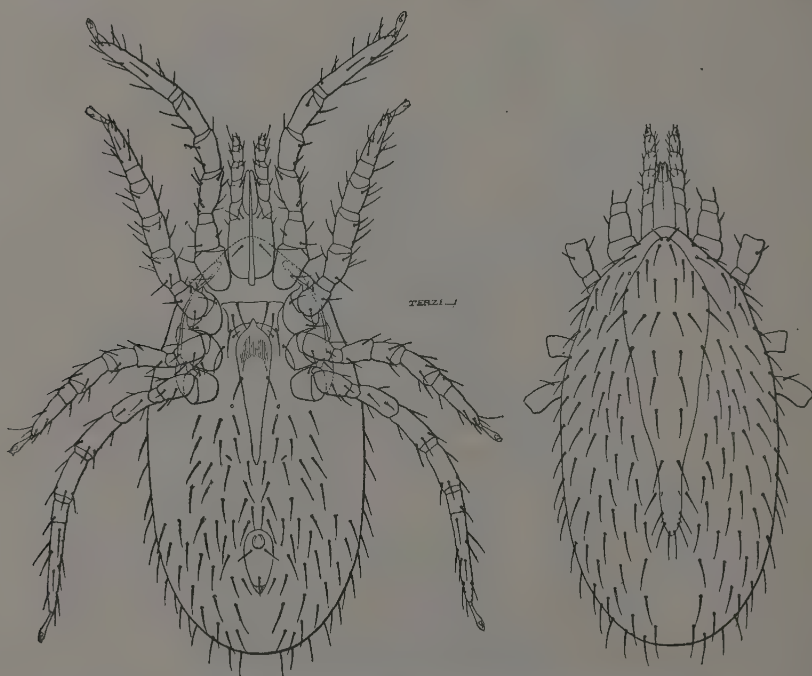

Fig. 12. *Leiognathus bacoti*, Hirst, ♀; ventral and dorsal aspects.

long, narrow, and furnished with eight or nine pairs of long hairs and the usual unpaired posterior hair; it is slightly narrowed before the anal portion. *Peritreme* extending as far forwards as the anterior surface of the coxa of the second leg or somewhat further. Fingers of *chelicera* short and difficult to make out. *Length* of body, ·43 mm.

Protonymph. *Anterior dorsal shield* of moderate size and provided with twenty hairs (arranged as shown in fig. 14), all of them being long, except those of the first pair. *Posterior dorsal shield* situated at the extreme end of the body and furnished

with three pairs of long hairs, those of the anterior pair, however, are often considerably shorter than the others; one or two pairs of exceedingly minute and inconspicuous hairs may also be present on this shield, in addition to the long ones. Between these two principal shields there are two pairs of minute *intermediate platelets*, those of the anterior pair being the larger; there are three central pairs of hairs on this unprotected part of the dorsal surface, the first pair being placed between the anterior pair of intermediate platelets; lateral hairs are also present. There is a minute platelet in front of the anterior end of the peritreme and another more

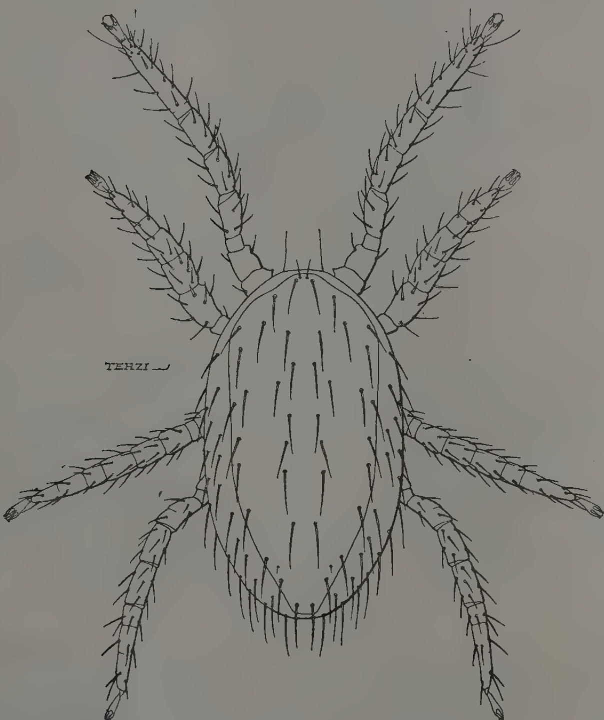

Fig. 13. *Leiognathus bacoti*, Hirst; dorsal view of male.

elongated platelet above the second coxa *Sternal plate* reaching backwards as far as the anterior surface of the last coxae, or slightly further; and furnished with three pairs of long fine hairs. Anterior end of *anal plate* practically straight. *Peritreme* short and curved. *Length* of body, ·4 mm.

The description of the male of *Leiognathus bacoti* is based on Australian specimens, no others being available, but females and nymphs from Egypt, Australia, and South America have been carefully compared with one another; I cannot find any difference between examples from these widely separated localities.

Egypt: Assiût town (on *Mus norvegicus*, *M. rattus* and *Acomys cahirinus*); and also on the feluccas at Assiût on the same hosts; most of the specimens were found on *Mus norvegicus*, which is apparently the principal host of this parasite.

Abyssinia: Harar; numerous specimens collected by G. Kristensen on *Mus* sp., 2. i. 1912, and presented to the British Museum by the Hon. N. Charles Rothschild.

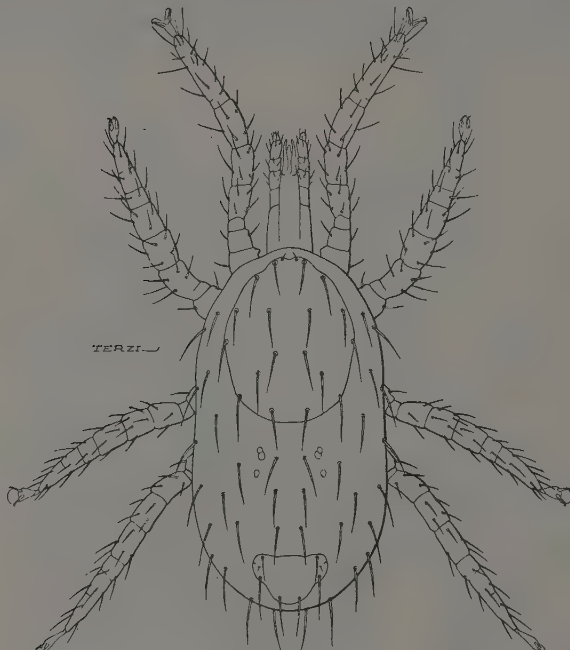

Fig. 14. *Leiognathus bacoti*, Hirst; dorsal view of protonymph.

Australia: (1) Specimens found on human beings and on the walls in a boot factory at Sydney, New South Wales; also others found in a rat's nest in the same factory. (2) Specimens found on walls of a seed shop at Sydney (biting human beings) and on a rat caught in this shop; the mites attacked the workers in these establishments, setting up very considerable irritation of the skin. (3) Specimens found on human beings at Perth, Western Australia, 2. xii. 1908. (4) Specimens biting at night on the wharves, Fremantle, Western Australia. All these Australian examples of this mite were sent to the Museum (except those from Perth, which were sent to the Quick Laboratory, Cambridge) by Dr. J. Burton Cleland; my best thanks are due to him for his kindness in sending me these specimens for examination.

South America: Numerous examples found by Dr. E. Giacomelli on a rat at La Rioja, Argentine, March 1912; presented to the British Museum by the Hon. N. Charles Rothschild.

Leiognathus bacoti is apparently closely allied to *L. saurarum*, Oudms., and to *L. musculinus*, C. L. Koch. The female of *L. saurarum* has its dorsal shield shaped very like that of *L. bacoti*, but the hairs on it are differently arranged, only a single pair of short hairs being present near the posterior end of the shield, instead of several rather long pairs as in *L. bacoti*. The protonymph of *L. musculinus* (as figured by Oudemans, Tijdschr. Nederland. Dierk. Ver. (2) vii, pl. 8, figs. 19 and 20, etc., 1902) presents a very close resemblance to that stage of *L. bacoti*, especially as regards the shape of the little posterior dorsal shield and the number of hairs on it; the female of *L. musculinus* is very different, however, from that of *L. bacoti*, being furnished with two dorsal shields instead of one.

5. **Laelaps echidninus,** Berl.

EGYPT: Assiût; thirty-two specimens captured on *Mus norvegicus* and three on *Mus rattus alexandrinus* on the feluccas.

This species is probably cosmopolitan.

Family ARGASIDAE.

6. **Argus persicus,** Fischer.

EGYPT: Assiût; a nymph and two larvae found on *Mus rattus*, and two distended larvae found on *Arvicanthis niloticus* (in houses).

7. **Ornithodorus erraticus,** Lucas.

EGYPT: Assiût; about fifty specimens (nymphs and larvae) found on *Mus rattus*, and a nymph and a larva from the same host on the feluccas; three nymphs and six larvae from *Arvicanthis niloticus*. El Hasaiba, Deirût; three nymphs and one larva from *Mus rattus*.

The specimens listed above seemingly belong to *Ornithodoros erraticus*. There are no lateral expansions to the camerostome, but the body has a projection above the mouth-parts as in *O. talaje* var. *capensis*, Nn. Dorsal surface furnished with numerous distinct but very fine granules; discs obsolete or absent. Eyes apparently absent.

Family IXODIDAE.

8. **Rhipicephalus** sp.

EGYPT: Assiût; a large number of nymphs and larvae from *Acomys cahirinus* and also fifteen from *Mus rattus*.

REMARKS ON A SMALL COLLECTION OF COCCIDAE FROM NORTHERN AUSTRALIA.

By E. Ernest Green, F.E.S.

The material under consideration was collected by Mr. G. F. Hill, Government Entomologist, at, or in the neighbourhood of, Port Darwin, in the Northern Territory of Australia. It consists principally of cosmopolitan species, two only being peculiar to the country.

Aspidiotus (Chrysomphalus) fodiens, Mask.

"On *Pithecolobium moniliferum*; Darwin, N. T., 1. ii. 1914."

The insects are densely massed on the under surface of the leaves and occur—though not in quite such large numbers—on the upper surface also. Male and female puparia are mingled together in approximately equal numbers.

I have no hesitation in determining this insect as *fodiens*, though it is remarkable that the infested leaves show no indication of the "pitting" described by Maskell as characteristic of the species, which derives its name, indeed, from this very peculiarity. All the structural characters of the insect itself are in close agreement both with Maskell's somewhat loose diagnosis and with Leonardi's more careful description (said to have been drawn up from typical examples). Maskell's figures are unfortunately quite unreliable, the different parts being represented out of all due proportion to each other. But one character to which he particularly draws attention (even exaggerating it in his figure) is a strongly developed acuminate marginal prominence on each side of the pygidium, just outside the last fimbriate squame. This prominence is particularly well marked in the present examples (*vide* fig. 1). Leonardi's figure—otherwise admirable—does not sufficiently accentuate this feature.

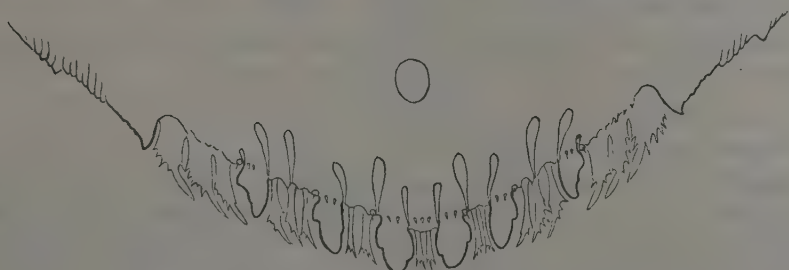

Fig. 1. *Aspidiotus fodiens*, Mask.; pygidium of adult female, × 600.

The fact that these specimens are not associated with depressions in the leaves upon which they rest is of no specific importance. The phenomenon is probably dependent upon the nature of the tissues of the plant involved. Maskell's typical examples of *fodiens* were occupying depressions in the leaf of an undetermined species of *Acacia*.

I have noticed a similar difference in habit with *Aspidiotus putearius*, in Ceylon, a species which is associated with still more pronounced pits when occurring on leaves of *Strobilanthes viscosus*, while the same insect attacks other species of *Strobilanthes* without any such result.

Aspidiotus fodiens is known from Australia only.

Aspidiotus orientalis, Newst.

"On banana leaves and on papaw fruit and leaves; Darwin, N. T., 1. i. 1914."

The examples submitted appear to be on the dried rind of the papaw (*Papaya carica*), where they occur in large and dense clusters containing both sexes.

This species has not previously been recorded from the Australian region. It occurs commonly, upon various plants, in India and Ceylon, and I have examples collected in Arabia.

Aspidiotus (Chrysomphalus) ficus, Ashm.

This cosmopolitan species is represented by heavily infested leaves of coconut palm, "Darwin, N. T., 10. xii. 1913." Also, in association with *Mytilaspis citricola*, on *Citrus acida*, "Botanic Gardens, Darwin, N. T., 12. xii. 1913."

Aspidiotus destructor, Sign.

"On leaves of the coconut palm; Botanic Gardens, Darwin, N. T., 11. vi. 1913."

Hemichionaspis minor, Mask.

(*a*) "On *Buchanania* sp.; Darwin, N. T., 24. i. 1914."

The infestation has been very heavy, but has been most effectively checked by the agency of natural enemies. Every single individual (and there must have been several thousands of them on a single leaf) has been destroyed either by Coccinellid beetles or Chalcid parasites. Had it not been for the empty skins of such specimens as had fallen victims to the Chalcid, I should have been unable to determine the species. Where the Coccinellid has been at work, nothing remains but fragments of the puparia.

(*b*) "On Kurrajong tree; Darwin, N. T., 24. i. 1914."

This sample consists principally of male puparia, massed on the twigs of the tree. The few female insects have been exterminated by parasites.

(*c*) "On indigenous vine, *Vitis* sp.; Darwin, N. T., 2. ii. 1914."

The same remarks apply to this sample.

Hemichion. minor is recognised, in the United States of America, as an important pest of the cotton plant. The Department of Entomology of that country has been seriously studying means of combating the pest and has deputed one of its specialists to search the world for an effective natural enemy of the insect. Consideration of the above samples suggests that such an enemy might be looked for in Northern Australia, with some hope of success.

Chionaspis dilatata, Green.

"On *Pandanus odoratissimus*; Darwin, N. T., 24. i. 1914."

This species appears to be widely distributed throughout the Oriental region, but has not hitherto been recorded from Australia. *Ch. eugeniae*, Maskell, to which it is closely allied, differs from *dilatata* in having the pygidium broadly rounded and the median lobes more widely divergent. The species appears to be held in check (in Australia) by the same parasites that affect *Hemichion. minor*.

Mytilaspis citricola, Packard.

"On lime trees (*Citrus acida*); Botanic Gardens, Darwin, N. T., 12. ii. 1913."

The leaves submitted are thickly covered on their upper surface with the mingled puparia of this species and *M. pallida*. These samples show no signs of parasitisation.

Mytilaspis pallida, Green.

"On lime trees (*Citrus acida*); Botanic Gardens, Darwin, N. T., 12. ii. 1913."

Intimately associated with *M. citricola* (as noticed above).

This species differs from *citricola* in the very narrow parallel-sided puparium of the female. It may be readily distinguished from *gloveri* (which it otherwise closely resembles) by its pale ochreous colour, the puparium of *gloveri* being deep reddish brown.

Parlatoria ziziphus, Lucas.

"On lime tree (*Citrus acida*); Darwin, N. T., 20. iv. 1913."

The insects are massed on both surfaces of the leaves to an extent that must have been most deleterious to the health of the plant.

Lecanium (Saissetia) hemisphaericum, Targ.

"On undetermined shrubs and weeds; Botanic Gardens, Darwin, N.T., 10. x. 1913."

Lecanium pseudexpansum, sp. nov.

Adult female (fig. 2, *b*) broad and flat; broadly oval, often of very irregular outline.

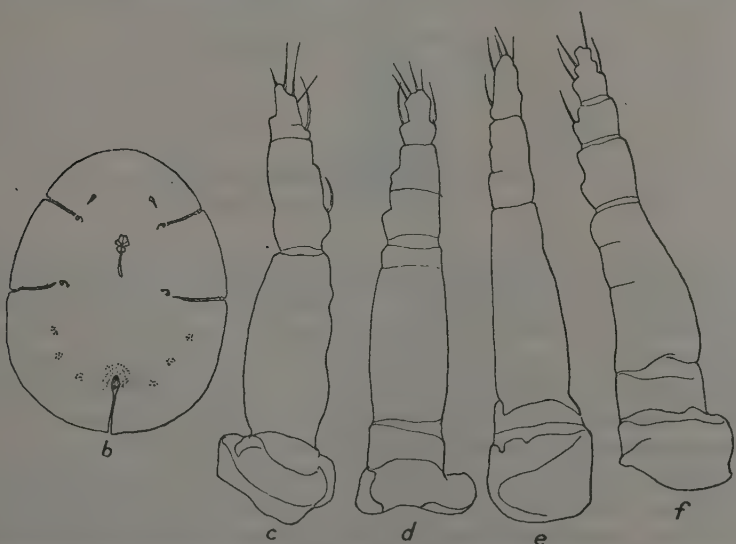

Fig. 2. *Lecanium pseudexpansum*, sp. nov.; *b*, adult female, × 9; *c-f*, various forms of antennae, × 600.

Colour pale fulvous or ochreous; often marbled with dark brown, and usually with a submarginal narrow dark brown zone. Surface (under magnification) minutely pustulate; appearing smooth and shining to the naked eye, but with indications of

shallow polygonal depressions covered by glassy concentrically marked plates of colourless secretion. Antennae (fig. 2, *c–f*) small, with confused and often distorted joints. Usually 6 joints can be distinguished, of which the 3rd far exceeds in length any of the others. Legs altogether absent. Stigmatic area (fig. 3) deeply incised, the inner margin rounded and thickened. Stigmatic spines three, approximately of equal size, stout, round or bluntly pointed at extremity; the centre spine is set further back than the other two, and consequently appears shorter, though occasionally it is longer and projects beyond the others. A shallow groove on the ventral surface extends from each stigmatic cleft to the corresponding spiracle. Marginal setae simple, pointed, about one-third the length of the stigmatic spines. Anal cleft occupying approximately one-fifth of the total length of the body. Valves of anal operculum triangular, the distal angle acute, the lateral angle obtuse. On the venter, immediately in front of the anal ring, are three concentric arches composed of groups of

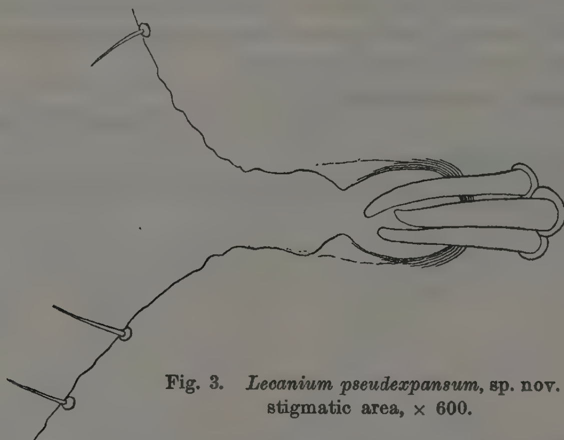

Fig. 3. ***Lecanium pseudexpansum*, sp. nov.; stigmatic area, × 600.**

small dorsal ceriferous pores, and there are groups of small dorsal pores at intervals on the medio-lateral area of the abdomen. Crowded subcircular cells are noticeable in the thicker parts of the derm, near the margin. Length, 4·25 to 5·50 mm.; breadth, 3·50 to 4 mm.

Male puparium glassy, divided by raised lines into 18 plates, of which three are central and fifteen marginal. Length, 2 to 2·50 mm.; breadth, 1·25 mm.

" On *Pandanus odoratissimus*; Koolpinyah, near Darwin, N.T."

The superficial resemblance of this species to *L. expansum* is quite remarkable; so much so, that I was at first prepared to accept it as such, without further examination. But the simple character of the marginal setae (which are flabelliform in *expansum*) places *pseudexpansum* in quite another section of the genus. Nor is the resemblance purely superficial, for the structure of the antennae, the absence of limbs, and the disposition of the pre-anal ceriferous pores, are all common to the two species. The male puparia of the two species are indistinguishable.

FOUR NEW INJURIOUS WEEVILS FROM AFRICA.

By Guy A. K. Marshall.

Eremnus fulleri, sp. nov. (fig. 1).

♂ ♀. Colour piceous, with dense light earthy-brown scaling, usually with a very variable and often indistinct mottling of greyish and blackish scales; the thorax with three indistinct paler stripes.

Head very convex, separated from the rostrum by a broad, shallow impression, the finely rugose sculpturing quite hidden by the scaling; forehead evidently narrower than the rostrum and with no central fovea. *Rostrum* stout, about three-fourths the length of the prothorax, almost straight and parallel-sided; a broad groove running backwards on each side from the scrobe to the eye, so that the central dorsal area is left as a broad parallel-sided ridge with a shallow impression in the middle; the genae broadly impressed below the scrobe. *Antennae* with the scape rather slender and gradually clavate, clothed with dense scaling and appressed setae; the funicle with joint 2 very slightly longer than 1. *Prothorax* evidently broader than long, especially in the ♀, the greatest width behind the middle, the sides strongly rounded, with a broad shallow constriction at the apex, which is much narrower than the base, the dorsal apical margin straight, the ocular lobes slight and with very short vibrissae.

Fig. 1. *Eremnus fulleri*, Mshl., ♀.

Scutellum minute, with dense pale scaling. *Elytra* broadly ovate in the ♀, narrower and more pointed behind in the ♂, the basal margin rather deeply sinuate; the striae and their shallow punctures almost entirely concealed by the dense scaling, the intervals almost plane, each with a single row of suberect scale-like setae, interval 7 with a very short elevated carina at the base which prevents the 7th stria from reaching the base and causes it to turn outwards into the 8th; the scales are small, nearly circular, and slightly imbricated. *Legs* densely clothed with pale scales and with broad recumbent setae, the femora without a tooth.

Length, ♂ 4·5–5, ♀ 5–5·5; width, ♂ 2–2·5, ♀ 2·5–3 mm.

Orange Free State: Wepener (*C. Fuller*).

The only other species of *Eremnus* with untoothed femora which has a similar humeral callus is *E. humeralis*, Fåhr., which can readily be distinguished from *E. fulleri*, among other characters, by the presence of small tubercles at the sides of

the thorax and at the base of intervals 8 and 9 on the elytra, as well as by the fact that the upper surface is set with very long, erect, slender setae.

Mr. Claude Fuller, Assistant Chief of the Division of Entomology, Pretoria, states that the adults of this weevil were found attacking the leaves of maize.

Hyperoides, gen. nov.

Head rather deeply sunk in the thorax, the forehead as broad as the base of the rostrum; eyes entirely lateral, elongate and coarsely facetted; head and rostrum together as long as the prothorax. *Rostrum* stout and very slightly widened apically, the apex entire; the mouth-parts as in *Hypera*; the scrobes only slightly oblique, widening behind and vanishing some distance before the eyes. *Antennae* with the scape extending well beyond the anterior margin of the eye, slender at the base and gradually clavate; the funicle with joints 1 and 2 equal, the former strongly, the latter slightly clavate; joint 3 a little longer than broad, 4–6 equal and as long as broad, 7 strongly transverse. *Prothorax* with well developed ocular lobes, which almost cover the eyes when the rostrum is withdrawn and bear conspicuous vibrissae. *Scutellum* small, quadrate. *Elytra* ovate, jointly sinuate at the base, which is not wider than the base of the prothorax, the shoulders rounded but prominent; the scales lanceolate and simply pointed at the tip. *Legs* slender; the tibiae with two short spines internally at the apex; the hind tarsi with joint 3 very slightly longer than 2. *Venter* with the anterior margin of the inter-coxal piece obtusely angulate, the posterior margin of segment 1 subtruncate, and segment 2 equal to 3 and 4 together.

Other characters as in *Hypera*.

This genus is nearly allied to *Hypera* (*Phytonomus*), which differs in the following points:—the eyes are finely facetted; the ocular lobes are feeble and scarcely cover the eyes at all; the forehead is always narrower than the base of the rostrum; and the tibiae have only a single internal apical mucro.

Hyperoides fragariae, sp. nov. (fig. 2).

Fig. 2. *Hyperoides fragariae*, Mshl.

♂ ♀. Black or piceous; the head and rostrum with recumbent pale setae; the prothorax with mingled brown, yellowish and whitish setae, and two rows of pure white setae down the middle; elytra with dense small greyish brown scales, variegated posteriorly on intervals 2, 3 and 7 with black and whitish scales,

interval 3 bearing a more distinct spot behind the middle; the upper surface set with long erect dark setae, most of which are minutely bifid at the tip; the under surface clothed with short recumbent and longer suberect white setae.

Head reticulately punctate and without any frontal fovea; the outline of the forehead continuous with that of the rostrum. *Rostrum* shorter than the prothorax, almost straight, the sides subparallel, the upper surface regularly convex transversely, with a smooth straight central carina and four or five narrow undulating longitudinal carinae on each side of it. *Antennae* slender, testaceous brown. *Prothorax* as long as its greatest width, gradually widening from the base to quite near the apex and then suddenly constricted, the basal margin rounded, the anterior margin straight dorsally; upper surface almost plane, with large reticulate punctures and with a curved transverse impression near the apex. *Scutellum* punctate and with depressed white setae. *Elytra* with the sides slightly rounded, the dorsal outline flat, the declivity gradual; the shallow striae distinctly punctate, the punctures visible through the scaling and each containing a minute white seta, the intervals between the striae slightly convex. *Legs* red-brown, rugosely punctate and clothed with white setae, the tarsi paler. *Length*, 5·5; width, 2·25–2·5 mm.

Cape Province: Rosebank.

A pair received from Dr. L. Peringuey with the statement that the insects were injuring strawberries. This is evidently the species referred to by Mr. C. W. Mally, Entomologist for the Cape Province, in his last annual report. He states that the weevils did considerable damage to strawberry plants about the time when the fruit was ripening. The larvae pupated in cells formed just below the surface of the soil.

This is the first species belonging to the subfamily Hyperinae that has been recorded from South Africa.

Tychius gossypii, sp. nov.

Colour black or piceous, with dense pale brassy scaling above and white scaling beneath; the elytra with an indistinct narrow sutural stripe.

Head with dense scaling, the forehead as wide as the base of the rostrum. *Rostrum* about as long as the prothorax, narrowing gradually from the base to the apex; behind the antennae it is dark and densely scaled, the apical portion being testaceous and bare. *Antennae* testaceous, with white hairs. *Prothorax* a trifle broader than long, very slightly widening from the base to the middle, thence strongly and roundly narrowed to the apex, with a shallow apical constriction, the base distinctly bisinuate; the disk is almost plane in the middle and is evenly covered with very close punctation, which is entirely hidden by the scaling. *Elytra* narrow, only slightly convex, with narrow shallowly-punctate striae, the intervals plane and rugosely punctate, the sculpturing being hidden by the scaling. *Legs* entirely testaceous, with dense white scaling, the femora not toothed.

Length, 2·25–2·5 mm.; width, 1 mm.

Egypt: Cairo (*F. C. Willcocks*).

This insect was found on cotton, but no information was sent as to the nature or extent of the damage done by it.

Superficially *T. gossypii* resembles *T. meliloti*, Steph., but the latter is a distinctly broader and more convex insect, with the forehead narrower than the base of the

rostrum, and the femora black; moreover, the scaling is much darker and has no metallic lustre, while the scales themselves are much narrower and more pointed, so that the surface of the thorax and elytra is plainly visible between them.

Cyllophorus rubrosignatus, sp. nov. (fig. 3).

♀. Black or piceous, with recumbent scale-like white and fuscous setae, and with the following markings composed of red scales :—a stripe from the base of the rostrum to the vertex of the head; two large round dorsal spots near the anterior margin of the prothorax, a similar spot just below these on each side, and a smaller transverse basal spot in front of the shoulder; on the elytra an irregular macular basal band extending to the 6th stria on each side, a transverse patch from stria 1 to 6 just behind the middle, a rounded lateral spot in front of the middle, and a similar spot near the apex; a small spot on the mesosternal epimeron.

Head with the narrowest part of the front only slightly broader than the funicle. *Rostrum* a little longer than the thorax, strongly curved, the apex somewhat flattened, the basal portion closely punctate and subcarinate in the middle, the remainder glabrous and with fine scattered punctures. Antennae testaceous brown, with the

Fig. 3. *Cyllophorus rubrosignatus*, Mshl.

apical joints blackish; joint 3 elongate, almost equal to 2; 6 and 7 subquadrate. *Prothorax* shorter than its width at the base, strongly narrowed in front, the sides slightly curved; the anterior margin rounded dorsally, quite straight at the sides, the basal margin strongly bisinuate; upper surface convex, highest near the base, shallowly constricted at the apex, the reticulate punctation indistinctly visible through the scaling. *Scutellum* elevated in the middle, covered with whitish scales. *Elytra* with the dorsal outline convex, deepest before the middle, the deep narrow striae indistinctly punctured, the intervals quite plane and their rugose sculpturing almost hidden by the scaling. Legs comparatively short, black, with dense white recumbent setae; all the femora with a short sharp tooth, the hind pair only slightly exceeding the elytra* and each bearing a single external carina. *Underside* with dense pale scaling, the posterior margin of the metasternum with a small shiny spot in the middle.

Length, 3·5–4·75 mm.; width, 2–2·5 mm.

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* They are shown much too short in the figure.

NATAL: Malvern (*C. N. Malvern*), Howick (*H. Dimock Brown*).

This very distinct little *Cyllophorus* may be readily recognised by its short hind legs and characteristic coloration.

Two specimens (without exact locality) have been received from Dr. L. Peringuey, Director of the South African Museum, with the information that the species is injurious to cultivated fig trees.

NOTES ON SOME INJURIOUS AFRICAN RHYNCHOTA.

By W. L. Distant.

Family Lygaeidae.

Oxycarenus amygdali, sp. nov. (fig. 1).

Head, antennae, rostrum, pronotum, scutellum, body beneath and legs black; posterior lobe of pronotum, posterior angular areas of prosternum, and a sub-basal discal suffusion to abdomen beneath, dark sanguineous; intermediate and posterior tibiae broadly annulated with pale luteous; corium and membrane pale grey hyaline, a black spot at apical angle to corium; head shorter than pronotum; antennae with the first joints reaching apex of head, second longest thickened towards apex,

Fig. 1. *Oxycarenus amygdali*, sp. nov.

third and fourth subequal in length; pronotum with the lateral margins distinctly pilose, posterior lobe granulose, anterior lobe more coarsely so; membrane extending beyond the abdominal apex.

Length, 4–4½ mm.

Transvaal: Amersfoort (*Claude Fuller*).

This species is reported as infesting the leaves of the peach. I have previously described another and somewhat allied species (*O. exitiosus*, Dist., "Entomologist," 1905, p. 169) from near Cape Town, which was also recorded as "injurious to peach." As there are now three allied species, the following synopsis may be useful:—

Pronotum with the anterior lobe black, the posterior lobe sanguineous:

Corium red; abdomen beneath sanguineous, the apex black. *O. annulipes*, Germ.*

Corium red, the lateral margins lutescent; abdomen beneath sanguineous, the apex and lateral margins black. *O. exitiosus*, Dist.

Corium pale grey hyaline. *O. amygdali*, Dist.

Arocatus continctus, Dist. (fig. 2).

Arocatus continctus, Distant, Ann. Soc. Ent. Belg., 1906, p. 410; Faun. Brit. Ind., Rhynch., v, p. 10 (1910).

* These characters are taken from Germar's description. I have not seen the species.

I originally described this species from specimens received from various localities in India and Ceylon. Dr. W. A. Lamborn has now brought it from Ibadan in Southern

Fig. 2. *Arocatus continctus*, Dist.

Nigeria (see p. 213), where he found it feeding on *Funtumia* seeds (Apocynaceae). This rubber tree is well known to be a native of Tropical Africa and is cultivated in India and Ceylon.

Family FULGORIDAE.

Subfamily DELPHACINAE.

Fig. 3. *Pundaluoya simplicia*, Dist.

Pundaluoya simplicia, Dist. (fig. 3).

Pundaluoya simplicia, Distant, Faun. Brit. Ind. Rhynch., iii, p. 468, fig. 255 (1906).

This species was originally described from a series of specimens sent to me by Mr. E. E. Green from Peradeniya, Ceylon. It has now been found by Dr. W. A. Lamborn breeding on the young shoots of kola and cacao at Ibadan in Southern Nigeria. It was also collected by Mr. Hugh Scott from " grass, etc., in cultivated places " during the Sladen Trust Expedition to the Seychelles on the islands of Mahé and Praslin.

Many of these Delphacids are widely distributed, largely incidental to the dispersion of seeds and plants. Dr. S. Matsumura, who has recently (Ann. Mus. Nat. Hung., v, p. 56, 1907) monographed another genus, *Tropidocephala*, gives the localities for one species, *T. brunnipennis*, Sign., as Japan, Formosa, New Guinea, Queensland, Singapore, Malacca, Madagascar, Caffraria, Cape Colony and Egypt.

A NEW COTTON-SEED MOTH (MOMETA ZEMIODES) FROM WEST AFRICA.

By John Hartley Durrant, F.E.S.

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Family Gelechiadae.

Mometa, gen. n. (μωμητός = to be blamed). Type: *Mometa zemiodes*, Drnt.

Antennae $\frac{2}{3}$, basal joint with distinct pecten; serrate and shortly ciliate in ♂. *Labial Palpi* long, recurved, both joints smoothly but somewhat thickly clothed, with furrow beneath; terminal joint distinctly shorter than median. *Maxillary Palpi* appressed to haustellum. *Haustellum* well-developed, scaled. *Ocelli* absent. *Head* and *Thorax* smoothly clothed with appressed scales. *Forewings* elongate-lanceolate, apex blunt-pointed: *neuration*, 12 veins; 7–8 stalked, 7 to costa; rest separate, 2 remote from 3, 5 approximate to 4; 1 basally furcate. *Hindwings* 1^+, trapezoidal, apex pointed, termen sinuate beneath: *neuration*, 8 veins; 6–7 very closely approximate toward base; 3–4 connate; 5 parallel to 4. *Abdomen* moderate. *Legs*: hind tibiae and the long basal joint of tarsi haired above, laterally compressed.

Mometa zemiodes, sp. n.

Antennae blackish above, ochreous beneath. *Palpi* and *Head* yellowish ochreous. *Thorax* fuscous-black. *Forewings* fuscous-black, with conspicuous, sharply defined, yellowish ochreous markings—a narrow fascia close to the base, a large round spot at the end of the cell, and a round costal spot on veins 9–10; cilia fuscous, with a darker line near their base; the ochreous spots do not show on the underside. *Exp. al.* 15–17 mm. *Hindwings* and cilia fuscous, with a paler line along the margin. *Abdomen* fuscous-black, the two basal segments and the anal segment ochreous above. *Legs* fuscous-black, the tarsi marked with ochreous.

Type ♂ (400088) BM.

Southern Nigeria: Ibadan, ⊕ in seeds of Cotton, 3. vii. excl. 19–21. vii. 1913 (*W. A. Lamborn*, no. 125).* Three specimens, presented by the Imperial Bureau of Entomology.

A very conspicuous species; in one of the specimens the two outer spots tend to unite, but the specimen is in poor condition.

*[For the habits of the larva, see p. 201.—Ed.]

TWO NEW SPECIES OF WOOD-BORING MOTHS FROM WEST AFRICA.

By Sir George F. Hampson, Bart.

Duomitus armstrongi, sp. nov. (Plate xvii, fig. 8).

♀. *Head* and *thorax* white; antennae black; palpi and sides of head black-brown; prothorax and sides of metathorax with tufts of long black hair slightly glossed with metallic blue, the patagia with black spots near base and black tips; pectus, legs and abdomen black-brown, the last with the dilated anal segment whitish, the rest of abdomen with tufts of long black hair on dorsum and at sides slightly glossed with metallic blue. *Forewing* grey, the base suffused with black-brown, the rest of wing with numerous black-brown spots which tend to become bars on terminal half below the cell and vein 4. *Hindwing* black-brown, with traces of deeper black-brown spots on terminal half.

Forewing with a forked veinlet in end of cell, vein 3 from long before end of cell, the median nervure bent upwards slightly just beyond it, vein 5 from above angle, 6 from well below upper angle, 7, 8 from angle, 9 absent, 10 from before angle, 11 from middle of cell; hind wing with a forked veinlet in end of cell, vein 3 from long before angle, 5 from just above angle, 6, 7 coincident, 8 free. *Exp.* 44 mill.

Gold Coast: Aburi (*L. Armstrong*) 1 ♀, type. The larva bores in the stem of coffee.

Genus Melisomimas.

Melisomimas, Jord., Entom., xl, p. 127 (1907).

Melisomimas metallica, sp. nov.

Melisomimas grandis, Jord., Entom., xl, p. 127 (1907), non descr.—nec *Melisa grandis*, Holland.

Head, *thorax* and *abdomen* black, the tegulae with some white hairs at base, the patagia with some white hairs at base of upper edge; coxae with some white hairs, the femora, tibia and tarsi white at tips; abdomen with some metallic blue suffusion. *Forewing* brilliant metallic blue, the basal area suffused with black; a more or less prominent tuft of white hair below base of cell. *Hindwing* brilliant metallic blue, some black suffusion at base of inner area; some white in submedian fold below end of cell and sometimes some white beyond the cell above and below vein 5. *Exp.* 30–44 mill.

Sierra Leone: (*Major P. Smith*) 1 ♀; S. Nigeria: Ibadan Distr. (*Dr. W. A. Lamborn*)* 2 ♀, type.

* [Bred from larvae boring in the bark of an *Albizzia*.—Ed.]

FURTHER NOTES ON THE BIONOMICS OF *TABANUS DITAENIATUS*, MACQ., AND *TABANUS TAENIOLA*, P. DE B.

By Harold H. King, F.L.S., F.E.S.

(*Government Entomologist, Anglo-Egyptian Sudan*; *Wellcome Tropical Research Laboratories, Khartoum.*)

(Plate XXVI.)

In 1909, the writer collected egg-masses of the seroot *Tabanus taeniola*, P. de B., and reared some of the resulting larvae to approaching maturity, but failed to obtain the pupa. The following year he took a number of immature larvae of *Tabanus ditaeniatus*, Macq., and reared them to the adult stage. The various stages in the life-cycles of these two Tabanids, with the exception of the pupa of the former and the egg-mass of the latter species, were figured and described in this Bulletin.* The puparium of *T. taeniola* and egg-masses of *T. ditaeniatus* which are here figured and described were obtained during the summer of 1913.

Tabanus taeniola, P. de B.

A nearly mature larva of this species was taken in wet soil at the edge of Khor Barboy, near Tonga, on the White Nile, on 20th June. It fed readily on earthworms till about 25th July, when it appeared to be mature. On 8th August it was found to have pupated; the eyes were coloured, but the rest of the pupa was yellowish-white. Later, the wings and other appendages darkened, and finally the abdominal markings of the adult could be distinguished. An adult male emerged on 19th August.

Pupa (Plate xxvi. figs. 3-5).—Length, 21 mm. Colour yellowish, thoracic tubercles and abdominal spiracles tinged with brown, the former bearing hairs. On the posterior third of each of the second to the seventh abdominal segments, inclusive, is a ring of backwardly projecting spines, shortest on the second segment and longest on the seventh, the spines yellowish, the ridge from which they arise chestnut-brown. The eighth segment terminates in a coronet of six teeth, chestnut-brown in colour, darker at the tips, approximately equal in size, arranged in a circle, the lateral teeth nearer to the dorsal than to the ventral teeth. Ventrally placed to this coronet is a transverse row of tiny teeth and dorso-laterally situated on either side is a comb of five teeth, the central ones being the longest and slightly longer than those on the ventral row.

Tabanus ditaeniatus, Macq.

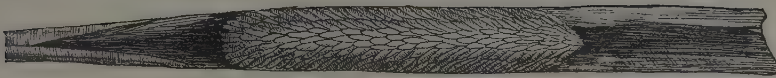
The egg-masses (Plate xxvi, figs. 1, 2) of this Tabanid were plentiful on grass growing in rain pools in the vicinity of Khor Barboy and at the junction of Khor Felus and the Sobat River. In shape they are very variable, some being long and narrow, others short and broad. Of the specimens collected the longest measured 20·5 mm. by 3 mm. and the shortest 8·5 mm. by 4 mm. The eggs are not covered with a secretion as are those of *T. biguttatus*, Wied. When freshly deposited the egg-mass is probably white to yellowish-white in colour, but all those taken varied from light to dark brown.

*Bull. Ent. Res., i, p. 102, and i, pp. 265–268.

The act of oviposition was not witnessed. The time occupied from the hatching of the egg to the emergence of the adult varied considerably. From an egg-mass which hatched on 24th June the first adult was obtained on 2nd November; while from another egg-mass which hatched on 25th July an adult was obtained on 11th September.

Of the egg-masses collected at Khor Barboy many were parasitised by an undetermined species of hymenopteron—probably a *Telenomus*.

Egg.—Length about 1·25 mm., of the typical Tabanid shape. As the embryo develops the ends of the egg darken, giving the egg-mass when viewed from a distance a general dark appearance.



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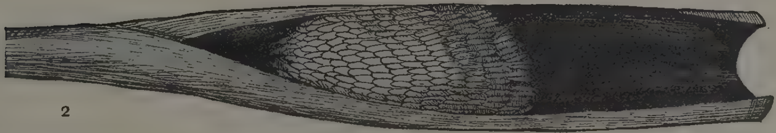

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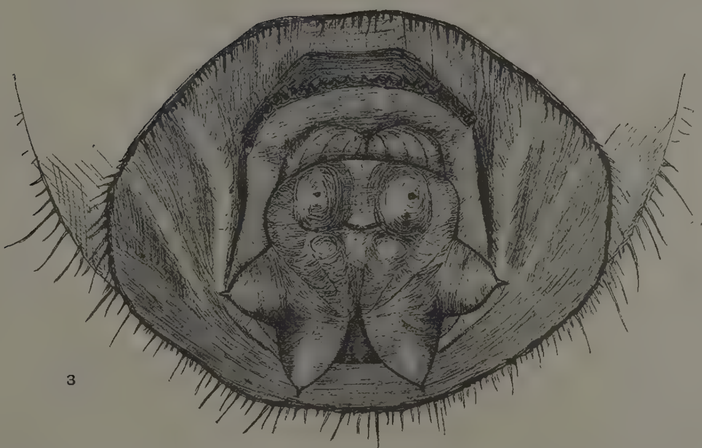
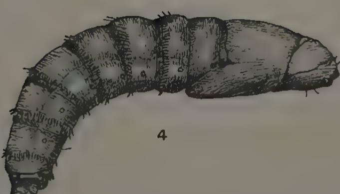
Egg-masses of *Tabanus ditæniatus*.



3

Posterior view of eighth abdominal segment of pupa of *Tabanus tæniola*.



4

Lateral view of pupa of *T. tæniola*.

5

Lateral view of anal segment of pupa of *T. tæniola*.

NOTES ON AFRICAN CHALCIDOIDEA.—I.

By James Waterston, B.D., B.Sc.,

Imperial Bureau of Entomology, London.

The following descriptions are based on material submitted by various collectors to the Imperial Bureau of Entomology. The types of the new species will be deposited in the British Museum.

Family Agaonidae.

In an interesting series of Fig Insects, comprising both caprifiers and inquilines, which have been forwarded by Dr. G. D. H. Carpenter from Uganda, are two species belonging to this family and representing respectively its main divisions.

The Sycophagine species appears to demand a new genus for its reception. Amongst its many noteworthy features, the most remarkable is the extreme development of the sub-apical spur of the first tibia into an organ comparable with the appendage to the mandibles so characteristic of the Agaonines.

For this new genus, the name *Sycoecus* (σῦκον, οἶκος) is proposed. *Sycoecus* affords a really extraordinary instance of homoplasy. The tibia is externally furnished with heavy, tooth-like spines, which, in conjunction with the flattened, small process, form a digging apparatus exactly similar to the mandible and appendage of *Pleistodontes*, etc. In these instances, therefore, the two sub-families have adopted the same device, but by modifying different organs. The tissue of the ovary, etc., of the fig is probably first dug into and torn by the teeth and then cut and swept aside by the lamina, which is in each case movable horizontally.

Both the Sycophagine (a few) and the Agaonine (very plentiful) occurred in the same species of fig, and sometimes together. There can, I think, be no doubt that the Agaonine species belongs to the genus *Agaon*, Dalm. (1818), about which little appears to be known at first hand. Dr. Carpenter's specimens may even be *A. paradoxum*, Dalm. (Svensk. Vet-Akad. Handl., xxxix, p. 69, 1818), but the thorax appears to be longer than in the genotype, while the petiole and first abdominal segment are maculate or banded. The original description is insufficient for specific determination. Having unsuccessfully tried to view the type, I have thought it better, meanwhile, to separate the Uganda examples from the Sierra Leone species.

Ashmead's table (Mem. Carn. Mus., i, no. 4, p. 233, 1904) should be corrected. In *Agaon* the head is less than $2\frac{1}{2}$ times as long as broad; the antennae have 11 not 12 joints; the third joint shows a distinct process, and the mandibles have 4 and not 3 teeth. *Agaon* appears to be most closely related to *Pleistodontes*, Saund. (Trans. Ent. Soc. Lond., 1883, p. 8), but the latter genus differs conspicuously in the antennae and legs.

Agaon fasciatum, sp. nov. (figs. 1 and 2).

General colour pale yellow-brown, with darker head and sheath of ovipositor, first tergite with a medianly interrupted dark band.

♀. *Head* flattened greatly, $1\frac{1}{2}$–$1\frac{3}{4}$ times as long as broad. Eyes reaching vertex, rather less than one-half length of head, placed mainly at the side and widely apart.

Vertex V-shaped, the sides clothed with short hairs; frons with sharp median sulcus, the sides contiguous to one-third from vertex, widening thence to scrobes, V-shaped in transverse section, with scattered short hairs except behind the scapes. Clypeus produced in a rounded median projection, between which and the scrobes are many short, stiff hairs. Antennae (fig. 1) 11-jointed, set at less than one-fourth from mouth edge; scrobes widely apart, narrow, slanting inwards and upwards, face triangularly excavated from this level to the edge of the clypeus; scapes large, opposed to one

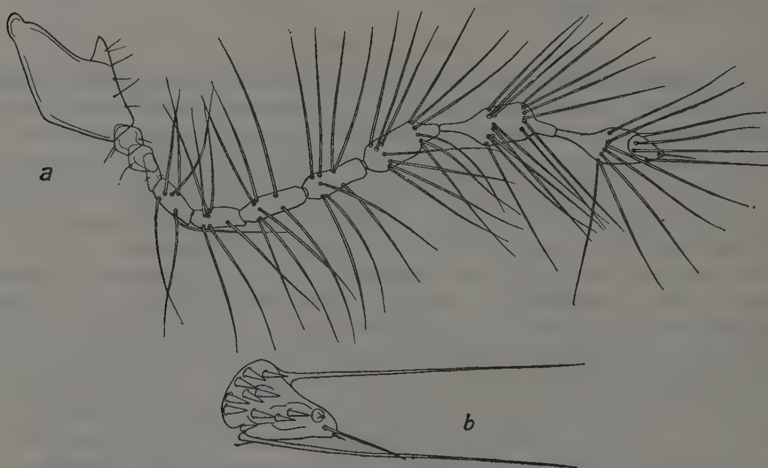


Fig. 1. *Agaon fasciatum*, sp. nov.; *a*, antenna; *b*, terminal sense-organ.

another along their much flattened triangular faces, with (at about one-half) a strong outwardly-directed process, which bears six short bristles; second joint transverse, short, with six bristles; third joint flat and round basally, thereafter drawn out apically to a sharp point, with one short, stout bristle; 4th joint cylindrical, short, rising from a depression in the third near the base, having 3 short bristles. Joints 5–8 (of which 5 and 6, and 7 and 8 respectively, are subequal) are similarly built; each bears near the base five or six very long tubular bristles and one or two more near the apex; 9 is half as wide again as 8 and bears 2 rows of the long bristles, as do 10 and 11; it is apically produced into a neck; 10 is produced into a neck in both directions; the 11th segment bears a sense organ composed of about ten short leaf-like hairs.

Mouth-parts (fig. 2, *a*, *b*).—Mandibles powerful, symmetrical, with 4 teeth on inner edge; one pair (apical and sub-apical) are equal, a third behind them shorter, a fourth small, with sometimes a trace of another behind. Under surface of the mandible with over a dozen sharp ridges; on the inner superior angle there is a strong broadened process for muscle attachment. Hinged to the mandible, but not interfering with its mobility, is a very long, backwardly directed and apically slightly outcurved rasping blade, reaching to the occiput. This appendage breaks easily from the mandible;

it is sharply serrate on the outer edge, and less distinctly so on its inner aspect; the lateral serrations are the terminal units of parallel rows (about 50) of teeth, numbering 15–20 per row. Maxilla laterally compressed and appearing like a blade between the saws attached to the mandibles; stipes in the form of a long, narrow strip (6 : 1), broadest near the apex; galea with two bristles; palpus entirely absent. Labium like a laterally compressed (5 : 1) spoon; palpi not certainly present; in their place and possibly homologous with them are two approximated slightly raised clear spots which give rise to a bristle; two minute distal bristles.

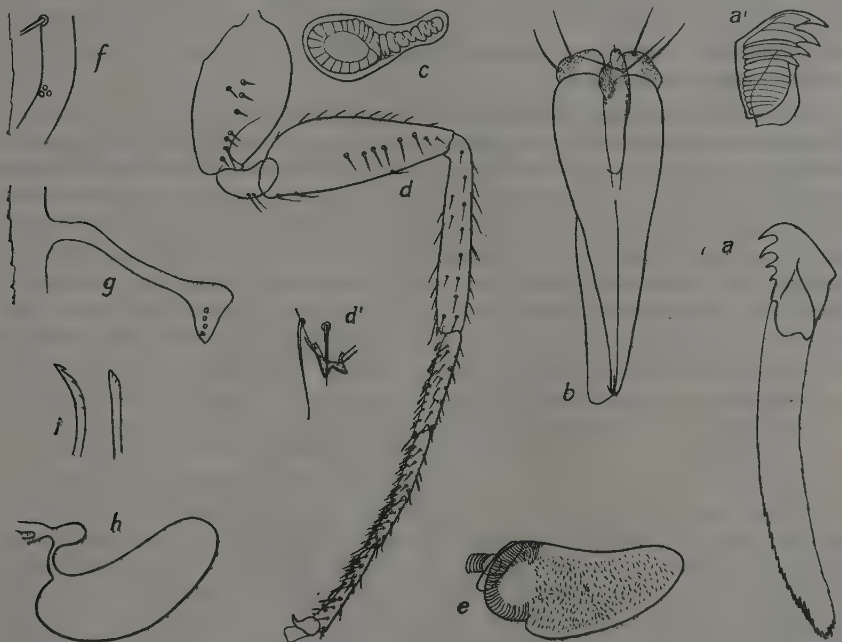


Fig. 2. *Agaon fasciatum*, sp. nov.; *a*, mandible and serrate appendage; a^1, mandible, under surface; *b*, trophi; *c*, metathoracic stigma; *d*, hind leg; *d'*, apex of hind tibia; *e*, caudal stigma; *f*, cells at junction of submarginal and marginal veins; *g*, radius; *h*, receptaculum seminis; *i*, apex of ovipositor.

Thorax.—Noteworthy in this region are the reduction of the pronotum, the development of the prothoracic spiracle, the mesonotum and the propodaeum. Pronotum short, angularly emarginate behind, consisting of two triangular sclerites connected by a narrow, membranous area. On each triangle there is an irregular row of bristles along the inner edge, a few more on the outer, and one or two on the surface near the posterior angle. Prothoracic spiracle with a strong, terminal chitinous cap, which, along with part of the trachea, projects clear of the side; this structure and the tegula are probably the two thorns or spines with which Dalman says his insect is provided on the sides of the thorax. Mesonotum triangular before the suture, coming to a point anteriorly in the middle of the prothorax; no definite parapsidal furrows; 4–6 short bristles posteriorly, on each side of an incomplete median line.

Tegulae conspicuous. Axillae bare, externally rectangular. Scutellum with a median impressed triangular area; over 20 short bristles in two irregular rows before the suture and mainly inside the triangle. Metanotum distinct, ribbon-like; the posterior margin broadly excised in the middle, with 4–6 minute bristles at each side. Propodaeum similar to the metanotum, but about twice as broad. Spiracle oval, with the anterior end narrower and debouching on a distinct stalk or ridge, so that the whole structure is pear-shaped (fig. 2, *c*); 5 short bristles behind the spiracle. Mesophragma long, narrow and distinctly entering the abdominal cavity. Prosternum diamond shaped, slightly truncate anteriorly, while the posterior angle is bifid and free from the thoracic surface. Mesosternal area anteriorly concave, with a strong median ridge, and posteriorly with six minute bristles on each side.

Abdomen.—Petiole very broad and dark, almost coextensive with the propodaeum. The abdomen conic-ovate and compressed, with V-shaped hollow on basal segments. First tergite almost unchitinised medianly, dark at the sides, with about 30 minute bristles on each side. The other tergites bare, but nearer the spiracle are one or two minute bristles. Spiracle (fig. 2, *e*) more than twice as long as broad, with a sharp narrow indentation on the lower proximal edge at one-fourth from base. Sternites with the chaetotaxy obsolescent, but on the ploughshare-shaped fifth sternite are some short hairs in two ventral rows. Stylet narrow; longer on the upper edge, where are 4 hairs, and 2 others at the apex. The ovipositor is from three-fourths to as long as the abdomen; the piercing part slightly longer than the sheath, which is black, edged with scattered bristles; apex of saw with 2 strong teeth (fig. 2, *i*).

Wings (fig. 2, *f*, *g*).—Forewing, length, 2·5 mm.; breadth, 1·1 mm. Hyaline, with a slight cloud below the upturning of the submarginal vein and in a line from the frenulum to the base. There are three faint venae spuriae from the end of the radius and two others from the base of the wing. The submarginal, marginal, postmarginal and radius are in the proportion:—8 : 3 : 5 : 2. Hindwing, length, 1·35 mm.; breadth, ·25 mm., with cilia nearly half as long as the breadth; remarkably long in proportion to the breadth, with rounded apex. Hooks of retinaculum on a distinct elevation. Submarginal vein broad basally, but tapering off before the hooks at about three-fourths. Colour clear, slightly clouded at the end of the single vein.

Fore legs.—Coxae compressed, 2½ times as long as broad; 6–8 bristles along anterior edge, chiefly on anterior two-thirds; bare externally, save on the upper or basal posterior third, where are 6–9 short spines; on the posterior edge and along the adjacent inner aspect, especially on the basal third, are numerous soft hairs; on the inside also are 3 longer apical bristles. Trochanter short, with 4–5 ventral bristles. Femur one-third longer than coxa, narrow on basal half, then expanded; greatest width one-fourth the length; on the outer surface are about a dozen bristles, which increase in length towards the apex; on the apical ventral region are numerous scattered hairs, besides a few on the anterior edge and a regular row (short) on or near the ventral. Tibia one-third of the femur in length; 2½ times as long as broad, with 2 short stout outer apical spines, one dorsal, the other ventral; many strong scattered bristles on the outer aspect and a few on the inner; the pre-apical ventral bristle not stoutly developed. Tarsus nearly thrice

as long as the tibia (14 : 5) and equal to the femur; proportional length of joints :—65, 17, 30, 20, 40 (excluding claw). *Mid legs* slender. Mid coxae narrowed basally, with straight anterior edge and rounded posteriorly; ½ longer than broad; 6–10 short bristles on each edge. Trochanter nearly equal to the coxa (23 : 25), with one sub-apical ventral bristle. Femur 5 times as long as broad, with subparallel sides; along anterior edge about 12 short bristles, on outer surface 10 bristles, the line curving upwards near the apex, 3–4 ventral bristles on basal third, and one longer preapical hair on inner median surface. Tibia considerably larger than femur, with numerous bristles, especially on the edges. Tarsus equal to the tibia; proportions of joints :—50, 43, 30, 25, 35. *Hind legs* (fig. 2, *d*).—Coxae large, pear-shaped, three-fifths as broad as long; a longitudinal median row of 4 short stout hyaline spines and a few bristles on the apical half of the inner surface. Femur only one-sixth longer than the coxa, considerably expanded dorsally; on basal third about 8 bristles in a ventral row and many along the dorsal or posterior edge and on the adjacent outer surface; beginning at one-third from the base on the inner surface is a row of 6–8 stout spines similar to those on the coxa. Tibia equal to the femur, slightly expanded distally, with numerous hairs and bristles, those on the outside chiefly in a submedian row, near the apex on the inside one or two are stronger; on the outside at the apex is a very short, heavy, bifid projection. Tarsus much longer than either femur or tibia; the first joint exceedingly bristly; proportion of joints :—75, 55, 50, 32, 50.

Length (excluding ovipositor), 3 mm.; alar expanse, 5·5 mm.

UGANDA: Bugalla Island, Sesse, Lake Victoria, Sept. 1912 (*G. D. H. Carpenter*). A series taken from an unopened wild fig (sp. nondum det.).

SYCOECUS, gen. nov.

♀. Antennae 11-jointed, inserted just below the middle of the face; the scape long and slender; pedicel short, followed by two ring joints; first funicular joint much expanded, joints 6–8 cylindrical, the last expanded distally; club of three segments. Head as a whole very long, mandibles powerful; labial and maxillary palpi present, with 2 and 4 joints respectively. Thorax much depressed, with very long pronotum. Wings with all the veins developed, the radius long. Fore legs with robust femora and shortened, heavily-armed tibiae; mid and hind legs normal in structure, the hind tibia longer than the femur. Abdominal tergites with narrow slit-like emarginations; the last spiracle circular; stylet narrow, distally expanded (fig. 3, *d*).

Sycoecus thaumastocnema, sp. nov. (figs. 3 and 4).

♀. *Head* greatly flattened, much longer than broad (5 : 3); from the insertion of the antennae to the vertex runs a broad depression, at the bottom of which are two narrow diverging furrows for the reception of the scapes; scrobes broadly oval, flattened on the inside. The ocelli are on different planes—viz.: a pair on the vertex (which owing to the shape and position of the head is hardly separable from the occiput) and a single median one on the frons above the scapes. Vertex exceedingly narrow, raised in a median rounded prominence, bearing on each side a short, stiff bristle; 3 bristles (of which the median is the longest) at each corner

of the vertex above the eye. Eye glabrous, touching the vertex at its upper angle; in proportion to the rest of the head small, occupying only about one-third of the length and less than one-fourth of the breadth, *i.e.*, the distance between the eyes is greater than their combined breadth; the head, moreover, is so flat that the greater part of the eye lies on the dorsal or morphologically frontal aspect. Head produced below the eyes, with one, and after an interval 4 hairs at the side; a

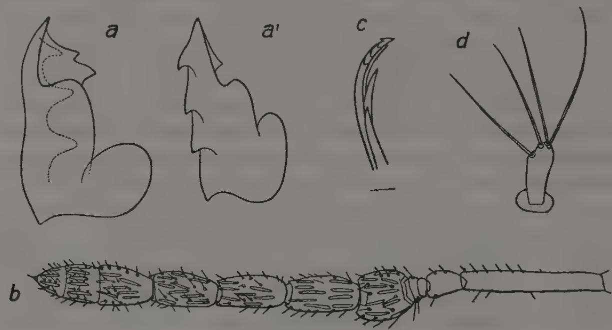


Fig. 3. *Sycoecus thaumastocnema*, sp. nov.; *a*, mandible, from above; *a*[1], mandible, side view; *b*, antenna; *c*, apex of ovipositor; *d*, stylet.

number of excessively minute bristles on the upper surface, irregularly disposed, but more numerous towards the mouth edge. Clypeus with the lateral angles reduced and rounded, its apical margin just slightly entrant, then produced into two broad lobes with a considerable incision between. Antennae (fig. 2, *b*) with the scape long and slender (6 : 1), with sub-parallel sides; pedicel short, expanded distally; two ring joints, closely united, the first minute; the first joint of the funicle (5th) is the broadest in the antenna, the breadth being nearly equal to the length; the sides strongly convex, joints 6 and 7 cylindrical, subequal and twice as long as broad; the eighth shorter, a little expanded distally; the club consists of three divisions, of which the first is the longest, the last joint showing a minute apical darker point, which can hardly rank as a joint. There appears to be no special apical sense organ, unless indeed the region just referred to be such; joints 5–11 bear numerous hairs and longitudinal sensory channels terminating apically in sharp points of clear chitin, raised a little from the segment surface to form a crown at the suture.

Mouth-parts.—Mandibles (fig. 3, *a*) powerful, on the outer aspect three strong triangular ridge-like teeth, a fourth at the apex and within two smaller sub-apical ones; seen from above, the posterior two-thirds of the mandible is flat, consisting of two rounded lobes, by the posterior of which articulation with the clypeus is secured. Trophi (fig. 4, *d*) normally developed; maxilla with the cardo short, stipes three times as long as broad, bare on ventral aspect, galea anteriorly incurved, with 5 straight bristles on the distal half, the apical being longest. Maxillary palpus 4-jointed (5, 5, 6, 9), third joint with one bristle, fourth with a long apical bristle and a slighter one near the base. Labium bare, palpus 2-jointed, with a minute sub-apical and a long straight terminal bristle. Lingua with 4 short stiff hairs on one-jointed tubercles.

Thorax.—Pronotum almost as long as the visible mesonotum, much produced and overlapping the mesonotum conspicuously behind; at the mid anterior edge a row of minute hairs, followed by an antemedian row of 4 bristles (the 2 central ones short) and 2 strong bristles placed post-medianly; on the overlapping sides of the pronotum there is a longitudinal row of about 7 moderately strong bristles; stigma small oval. Sternum diamond-shaped. Mesonotum parabolic, far underlapping anteriorly; parapsidal furrows distinct and broad; mid lobe bare, but on each side (just on the parapsidal furrows) are 3 bristles, the hindmost being generally the stoutest; lateral lobes with one bristle; axillae, with the outer angle a right angle, bearing one or two minute bristles, a stronger bristle on the suture with the

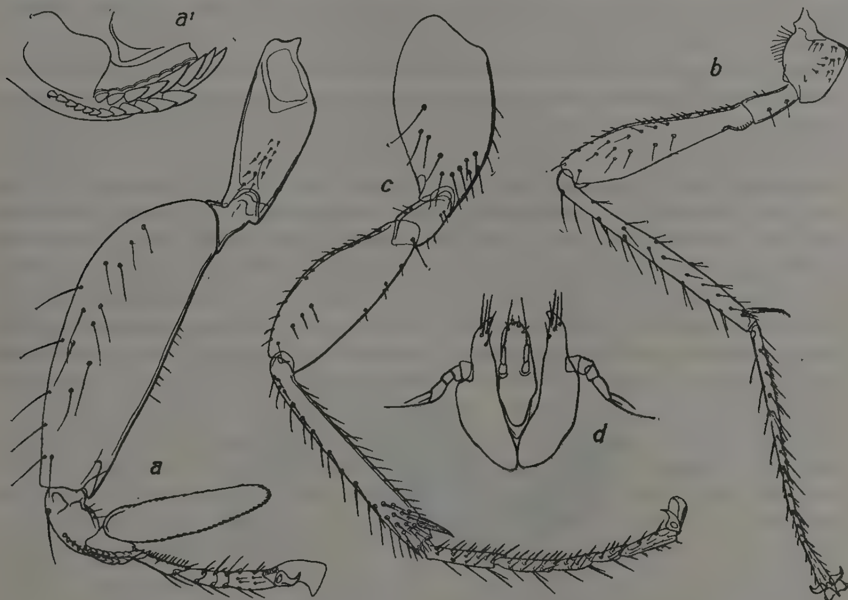


Fig. 4. *Sycoecus thaumastocnema*, sp. nov.; *a*, fore leg; *a*[1], spines on edge of fore tibia; *b*, mid leg; *c*, hind leg; *d*, trophi.

scutellum, which is bare medianly, but has two bristles on the hind edge; mesophragma long. Mesosternum consisting of four sclerites, two anterior and wedge-shaped, the bases being outwards, and two posterior, quadrate; the wedges are bare, save for a pair of minute bristles on the middle of the anterior edge; on the quadrate area behind there is a stout short bristle on each side of the middle line, with a patch of minute bristles (about 12) outside, while posteriorly there is a median longitudinal row of similar bristles (9) reaching the hind margin. The metanotum and the propodaeum are both collar-like; the former narrow; the stigma rounded, oval, with a bristle in front.

Abdomen.—First tergite with a peculiar backward process on each side; the other tergites with up to 8 clear slit-like striae running from the posterior margin; bare, save for one or two minute hairs on each side. Spiracle nearly circular, with about

25 bristles behind. Stylet (fig. 3, *d*) distally expanded, with 4 bristles, and 2 bristles on the tergite below; about 6 bristles between the stylets. Ovipositor shortly projecting, one-sixth the length of the abdomen; the saw downwardly recurved, the apex rather stout, recurved (fig. 3, *c*); the teeth (4) circularly but faintly cut; upper sheath practically as long as the saw, broad, with two scattered rows of hairs (each 10–12); lower sheath hardly reaching base of upper, with 7–8 ventral hairs on each side.

Wings.—Forewing, length, 1·8 mm.; breadth, 8 mm.; submarginal twice as long as marginal, radius developed strongly, long and gradually expanded; four terminal cells; post marginal moderate, two-thirds the radius; basal triangle of the wing (up to about the middle of the marginal vein) bare. Hind wing, length, 1·4 mm.; breadth, ·3 mm.

Fore legs (fig. 4, *a*).—Coxae more than twice as long as broad; trochanter short. Femur greatly developed; three times as long as broad, with a few scattered superficial hairs. Tibia short, thick, medianly bent and excavated, armed on the inside at the middle with an enormous rasp-like broad flat thorn or spine, which is nearly twice as long as the tibia itself and equally broad; the surface of the rasp is covered with rows (about 25) of flat scale-like teeth or spines (10–25 in a row); the edges and distal extremity are serrate and the number of teeth on the rasp is about 500; the tibia is broadest at its base, and before the median chitinous thickening it bears 7–8 hairs above, and one or two on the inside; behind the thickening there is on the upper anterior edge a double row of 7–8 short heavy triangular spines, one being apical and stronger than the others; there are also about 6 transparent stout bristles or spines on the inner or ventral apical edge behind the rasp. Tarsus with the first joint gradually expanded from base to apex, joints 2 and 4 of the same thickness, 5 again expanded; the claw robust, with two basal bristles; first tarsal joint with a ventral comb of about 9 short bristles and a subapical pair, dorsally with one hair at the middle and one pre-apical pair; joints 2–4 with one short stout subapical ventral bristle, another similar dorsal one and one at the side; joint 5 with two or three fine bristles on each aspect; proportional lengths of the joints:—40, 16, 14, 12, 35 (excluding claw). *Mid legs* (fig. 4, *b*) weak, but normal in structure. Coxa small, triangular, length (14) and breadth (13) sub-equal. The tarsus is long, just exceeding the tibia, which again is distinctly longer than the femur. Femur narrow basally, but slightly swollen on the apical two-thirds; over a dozen hairs along the upper edge, and a few more on both the outer and inner surfaces. Tibia with about 12 bristles on the upper edge, and 8 with a strong sub-apical spine below, on the outer surface a row of about 6. The tarsal joints are bristly and in the proportion 75, 45, 35, 25, 40. *Hind legs* (fig. 4, *c*) similar to mid legs, but the coxae are much larger, with a number of hairs, chiefly on the apical surface; seven-eighths the length of the femur and much broader. The tibia again exceeds the femur, and the tarsus the tibia; the sub-apical ventral spine of the tibia is short and heavy and above it is a patch of strong short bristles. Proportions of tarsal joints, 65, 45, 30, 22, 50.

Length, 3.5 mm.; alar expanse, over 4 mm.

UGANDA: Bugalla Island, Sesse, Lake Victoria (*G. D. H. Carpenter*).

A series of five specimens (all females) from an unopened wild fig.

Family Chalcididae.

Dr. Lamborn has submitted a species of *Chalcis* from Southern Nigeria differing from any hitherto described from Africa under *Chalcis* or *Oncochalcis*. It is abundantly distinct in colour, in dimensions and markings from *C. amenocles*, Walker (List. Hym. Brit. Mus. Chalcid., i, p. 84, 1846), and *C. visellus*, Walker (Ann. Mag. Nat. Hist., xvii, p. 109, 1846), both from Sierra Leone. To *C. amphilochus*, Walker (Ann. Mag. Nat. Hist., xvii, p. 109, 1846), from the same locality, it somewhat approaches in size, but the hind tibiae of *amphilochus* are apically lighter, the scutellum is posteriorly indented, and the first abdominal tergite closely punctate.

Chalcis olethrius, sp. nov. (fig. 5).

A small coarsely punctate species distinguished by the entirely black hind femora, the pale tegulae and the rounded posterior margin of the scutellum.

♂. *Head.*—Vertex and frons coarsely punctate. Antennae inserted below the middle of the face, but distinctly above the base of the eye, with 13 joints, viz. :— scape, pedicel, one ring and 7 cylindrical joints in the funicle, and the club divided by a distinct suture at about one-third and by another, indistinct and incomplete, near the apex ; all the funicular joints broader than long, the fourth (sixth) longest, and the seventh (ninth) shortest ; the first division of the club is two-thirds the second. The antennal furrows are separated near the scrobes by a slight median keel, but united towards the anterior ocellus which the scape just fails to reach. The orbits diverge steadily from the vertex downwards, and at the point where the eyes are at their widest the diameter of each is rather less than the width of the frons.

Fig. 5. *Chalcis olethrius*, sp. nov. ; hind leg (tarsus not shown).

Thorax uniformly covered above with thimble-like punctures, each having a slight central elevation bearing a bristle ; between the punctures, the surface of the thorax is rugose or reticulate. Prothorax, facing the occiput, coarsely punctate, save along a broad median line which is merely reticulate. Pronotum posteriorly narrowed by the mid lobe of the mesonotum. Mesonotum with distinct parapsidal furrows. As a guide to the degree of the puncturation of this region, it may be noted that parallel to the anterior edge of the mid lobe there are 18–20 thimble-like depressions, and on the posterior edge 6. Tegulae pale whitish yellow. Scutellum with the puncturation coarser than on any other region ; lateral and posterior bristles longer.

Fore wings, length, 2·9 mm. ; breadth, 1.1 mm.

Abdomen.—First segment covering more than half, its surface delicately reticulate, at least in the middle, but entirely shining ; second segment with all the dorsal

surface punctate (or, with good illumination, punctate reticulate, the points being faintly connected) and hence slightly dull; on segments 3–6 the punctured area is less extensive (nearly the basal third of each being clear and shining), but the punctures become progressively coarser; all the sutures between the segments shining. At the sides of all the segments are a few silvery bristles, and (except on seg. 1 and medianly on seg. 2) there is also a transverse row of bristles at the middle or a little in front of it.

Legs with all the coxae, the trochanters and the hind femora black; all the tarsi pale yellow, with a ferruginous tinge on the anterior pair; fore and mid femora black, save for a small apical yellow or yellow-brown spot above; fore and mid tibiae black, with a small basal yellow spot above, the apical fifth of each being yellow above and brownish beneath; hind tibiae black save for a long yellowish spot occupying the upper apical fourth or fifth. The hind femur bears nine teeth, 4 near the apex small, a fifth slightly larger, 6 and 7 larger, sub-equal, eighth smaller, the largest of all being at one-third from the base; about 25 short spines fringing the slanted apical edge of the hind tibia.

Length, nearly 4 mm.; alar expanse, 6–7 mm.

SOUTHERN NIGERIA: Ibadan, 3. vii. 1913 (*Dr. W. A. Lamborn*).

Host: a Tineid moth, *Pyroderces simplex*, Wlsm.; a single ♂ bred from the pupa.

There is also in Dr. Lamborn's collection a second ♂ apparently belonging to this species, which was bred from a Pyralid pupa (*Sylepta polycymalis*, Walk.) in the same locality, but both hind legs are wanting and the yellow markings of the tibiae are, if anything, more ferruginous than in the type.

SOME CEYLON COCCIDAE.

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All the species of scale-insects described in this paper were found at Peradeniya, Ceylon.

Aulacaspis flacourtiae, sp. nov.

Female scale indistinguishable from that of *Aulacaspis pentagona.*

Male scale white, uncarinated, clustered, standing out from the twigs often quite at a right angle.

Adult female almost circular, white, with pygidium yellowish-brown and segments in front of pygidium with lateral expansions which bear plates. The anterior stigmata with a group of parastigmatic glands, posterior spiracles without such glands. Median lobes alone well developed ; not sunk in a cleft, prominent, triangular, rounded at apex and but slightly serrated. Each lobe projects mesally into the pygidium and there is a similar projection between them. The other lobes and pore-projections are represented by mere chitinisations of the pygidium ; the second lobe may be slightly developed. Spines (setae) and plates as in *A. pentagona,* except that there may be 4 or 5 or even 6 immediately laterad of the second pair of pore-projections ; the plates mesad of this group are comparatively short, broad and blunt at apex. The dorsal pores on the pygidium are arranged in two broken arches that reach the margin of the pygidium at the third and fourth pairs of pore-projections ; there are no pores immediately laterad of the circumgenital pores. The abdominal segments bear numerous dorsal pores laterally, grouped on the anterior as well as the posterior region of the segment. Circumgenital pores are very numerous and arranged in grape-like clusters. One count gave 76 median, 51 cephalo-lateral, and 40 and 50 caudo-lateral ; another had 54 in the median group. There is a band of chitin on the mesal margin of the lateral groups of pores, and two transverse bars cephalad of the median group.

Adult male agrees with Green's description of the male of *D. amygdali* (*Aulacaspis pentagona*), except that the terminal segment of the antenna is considerably shorter than the preceding segment, and that the tarsal claw is broader at the base than in Green's figure. First exuvium (of ♂) with antennae large and 5-segmented, and situated on the anterior margin ; the terminal segment bearing numerous setae. Meso-caudad of the base of the antennae are two trumpet-shaped glands, these doubtless secreting filaments as in the pale larvae of *A. pentagona* (*vide* Green, Coccidae of Ceylon, i, p. 88). The abdomen is distinctly segmented, there being seven segments ; the apex of the abdomen is slightly concave and bears two long hair-like spines each associated with a comparatively large gland. Some show a distinct caudal notch with a short, stout spine on each side of the notch.

Eggs yellow or white.

This insect occurs along with *Howardia biclavis* on the twigs and branches of *Flacourtia ramontchii* and is doubtless the insect referred to by Green as "typical *Diaspis pentagona*" (Memoirs, Dept. Agr. India, i, no. 5, p. 346).

It seems sufficiently distinct to warrant its being considered a separate species. The number of circumgenital glands is much in excess of anything I have seen recorded for *A. pentagona*, for which Green gives (12–25) (30–46) (28–38); the plates, too, are more numerous.

The insect is preyed on by a small, light-brown Coccinellid with a *Pseudococcus*-like larva, and less so by *Chilochorus circumdatus*, and is parasitised by a small, black Chalcid.

Aulacaspis myristicae, sp. nov.

Secretion of female scale coarse, white or brown—the latter colour being due to a covering of hairs of the plant—oval in outline and enclosing the second exuvium; exuviae reddish-brown. Adult female pear-shaped; the median lobes set in a slight notch, short, narrowed at base, expanded disto-laterally and broadly rounded at apex. The second lobe is duplex; the lateral half is conspicuous and distinctly rounded at apex and is of much the same shape as the mesal half. In *Diaspis barberi*, Gr., which this insect somewhat resembles, the outer lobe of the first lateral lobe is said to be "very small, conical" (Mem. Dept. Agr. Ind., ii, no. 2). Laterad of the second lobe is a very prominent gland-pore and laterad of this a faintly chitinised, bi-lobed projection, each part serrated on the margin. Where the two rows of dorsal pores meet the margin the pygidium bears conspicuous projections. There is a group of 19 or 20 parastigmatic glands associated with the anterior spiracles; the posterior spiracles are without such glands. There are no dorsal pores immediately laterad of the circumgenital pores. (Such pores are figured as present in *D. barberi*, Gr., and *D. fagraeae*, Gr.). The abdominal segments in front of the pygidium bear numerous dorsal pores. The circumgenital pores are in five grape-like groups. Four individuals showed pores as follows:—17 (37 and 34) (36 and 56, these 56 somewhat scattered); 14 (32 and 28) (30 and 32); 17 (32 and 34) (26 and 30); 15 (32 and 34) (32 and 34). There are two plate-like projections associated with the pore laterad of the median lobes; other plates 1, 2–3, 4–8, 9–11.

On midrib of leaf of *Myristica laurifolia* (Wild Nutmeg), 15. vii. 1913.

This insect resembles somewhat *D. fagraeae*, Gr., but the plates in the fourth space are more numerous, the circumgenital pores are more numerous, *D. fagraeae* having (8–10) (15–18) (20–30), and the median lobes are of a different shape.

As compared with *D. barberi*, Gr., the median lobes are not expanded distally on both sides, but only laterally, they are not slightly incised, and the circumgenital pores and the plates are more numerous, *D. barberi* having pores as follows:—(6–9) (18–23) (19–23).

Pseudaonidia oreodoxae, sp. nov.

The scale is partly concealed underneath the bark of the tree. The secretion is dark-brown, the exuviae orange; leaves a white ventral scale.

Adult female dark purple, flat on the venter, convex dorsally. There are two smooth shining areas at the base of the abdomen on the venter, one on each side. There is a slight constriction one segment caudad and another five segments caudad of the main constriction. The median lobes are the largest and are usually broadly rounded; they may be slightly notched on the mesal and lateral sides. The second

and third lobes are smaller and very similar to each other in shape, the second being the larger; each is rounded at apex, bears a prominent notch on the lateral side, and is slightly inclined towards the apex of the pygidium. Laterad of the third lobes there are several sharp-pointed processes on the pygidial margin. There are six club-shaped paraphyses resembling those in *Aspidiotus maleollus*, Gr., to which this insect bears some resemblance; the body, however, is not hammer-shaped, nor are there any circumgenital pores; the body contains larvae. The pairs of paraphyses laterad of the third lobes is inconspicuous. Between the median lobes there is a distinct chitinised area of the pygidium. The plates are inconspicuous; there is a short plate laterad of the median lobes and one or two laterad of the second lobe. Bands of minute pores run cephalad from the margin of the pygidium. Long setae are arranged as follows:—0, 2, 2, 2, 2, increasing in length cephalad.

On stem of Cabbage Palm (*Oreodoxa oleracea*); also on Royal Palm (*Acalypha* sp.) and *Broussonetia papyrifera*, Vent.

On *Broussonetia* the scales have the exuviae yellowish-brown or yellowish-green in colour.*

This insect falls near to *Pseudaonidia tesserata*, de Ch., but the lobes are very different from those figured by Newstead in this *Bulletin* (iv, p. 309). It is without the plate-like process which Newstead figures laterad of the third lobes, having two setae in this position.

Pseudaonidia irrepta, sp. nov.

Scale completely concealed underneath bark of plant. Adult ♀ slightly longer than broad, cephalic extremity flattened, caudal pointed. Metathorax and first and second abdominal segments distinctly produced laterally.

Female on slide about 2 mm. long. Median lobes large, rounded at apex, with a distinct notch on the lateral side. The second and third lobes are much smaller, but distinct, rounded on mesal side and at apex, prominently notched on lateral side; the notch may be absent in the case of the second lobe. Pygidial margin laterad of the third lobes with numerous prominent tooth-like processes. Two pairs of paraphyses, a long pair between first and second lobes, and a pair of about half the length between the second and third lobes. The apex of each paraphysis is a round knob which stands out the more prominently because the region immediately caudad of it is more feebly chitinised. A long seta and two short plates between the second and third lobes, and between the third lobe and the first tooth-like process; a seta between first and second, and another between second and third teeth. Anterior spiracles with about 11 parastigmatic pores; posterior spiracles without such pores. Anus narrow. Circumgenital pores in an arch round the vagina.

On branches of an undetermined plant (possibly *Acalypha* sp.).

The insect is attacked by Hymenopterous parasites, whose exit holes are often the only indication of the presence of the scale-insect. This species falls near *P. clavigera*, Ckll., but the latter has three pairs of paraphyses.

* I have specimens of this insect also from Cuba, and in these the parastigmatic glands number from ten to eleven. The unborn young have a prominent pair of lobes, each with two notches on the mesal and three on the lateral obliquity near the apex of the lobe.

Aonidiella pothi, sp. nov.

Female scale of a very dark brown colour and shining. The first exuvium has a reddish tinge. The whole scale is slightly elongated, with the exuviae towards one end. When removed a faint white ventral scale is left. A pair of short club-shaped paraphyses between the first and second lobes, and similar paraphyses more or less distinct between second and third, and third and fourth lobes. Between these and cephalad of the median lobes there is a chitinous knob. The antenna consists of a tubercle bearing a long seta. The median lobes are somewhat triangular in shape, with a distinct point at apex mesally, sometimes an apical notch, a notch on the lateral margin near apex and on the mesal margin near the base. The second lobes are narrower than the median, longer than broad, convergent caudally, pointed or rounded at apex, with the lateral margin distinctly notched. The third lobes are as broad as long, divergent caudally, notched on both sides, rounded at apex; the mesal notch is sometimes indistinct. The fourth and fifth lobes are more or less distinct, triangular, serrated, the pygidium in the interval between them also being serrated. There are two pectinae between the median lobes, two between first and second lobes, three between second and third lobes, three between third and fourth lobes; all are shortly three- or four-pronged at apex. There is a seta laterad of the mesal lobes; two laterad of second lobes, one being on base of lobe; two laterad of third lobes, one being on the lobe; two laterad of fourth lobe, one being on the lobe; and three on the margin of the pygidium cephalad of fourth lobe. The anus is longer than broad. There are no circumgenital pores. Plates of chitin serrated on the caudal edge surround the anterior margin of the vagina, giving a faint tessellated appearance.

The insects contain larvae with antennae, legs, mouth-parts and pygidial lobes well developed; the lobes are two in number, conspicuous, produced into the pygidium, converging caudally, rounded at apex, with one notch on the mesal and two on the lateral side.

The antennae distad of the fourth segment are ringed and end somewhat abruptly.

On *Pothos scandens*, chiefly at the nodes under the bud scales; also on *Loranthus* sp.

This insect falls near *Aspidiotus glomeratus*, Gr., from which, however, it is quite distinct.

Hemichionaspis alatae, sp. nov.

Female scale very inconspicuous, about 3 mm. long, of a dull, pale brown colour. The exuviae are situated at one end and are of much the same colour as the rest of the scale. The secretion is comparatively broad. The second exuvium has a slight but distinct median longitudinal ridge.

Male scale white, tricarinate, in dense clusters and lying flat on the twigs.

The median lobes of the adult female are large, extending slightly caudad of second lobes, the lateral edges sloping away to the pygidium and with three or four distinct notches. The second lobes are duplex, feebly chitinised but distinct, each half expanded towards the apex. Third lobe sometimes developed, duplex, mesal half longer than broad, lateral broader than long, both serrated on margin.

Between the first and second lobes there is a very prominent gland-pore projection, distinctly longer than broad, and sometimes projecting further caudad than the second lobe. The gland-pore projections laterad of the second lobes are also conspicuous. Plates 1 (small), 1, 1, 1 or 2, 3. There is a small seta at the base of the median lobes, and a larger seta laterad of them; two setae connected with the second lobe, and two, one of which is small, connected with the third lobe; one laterad of the two gland-pore projections beyond the third plate. Dorsal pores few but large and oval. Circumgenital pores (8–10) (20–23) (17–23).

Adult ♂ orange-red, with whitish wings; tarsus shorter than tibia and with two digitules; a single hair at the apex of the antenna.

On branches of *Carsia alata*.

It is subject to the attack of Hymenopterous parasites and is preyed on by Coccinellid larvae.

This insect is near *H. minor*, Mask., and may be a variety of that insect. *H. minor*, however, has "female puparium *white*" (Maskell; Cooley), "opaque snowy white, often specked with brown" (Green—*Ch. albizziae*, Gr.). Further, the lateral lobes of *H. minor* are ordinarily less well developed. It may be merely a variety of *H. aspidistrae*, Sign., which seems to be a very variable insect.

Chionaspis malloti, sp. nov.

Female scale more or less circular, convex, covered with hairs from the food-plant. Exuviae eccentric, covered with secretion; when rubbed are seen to be of a light orange-yellow colour. When the scale is removed a white mark is left on the twig. No exuviae are to be seen from the ventral surface, being hidden under a covering of white wax.

Male scale not observed.

The insect when treated with KOH and mounted on a slide is slightly longer than broad, rounded anteriorly and bluntly pointed posteriorly. There is but one lobe, evidently formed by the fusion of two. This lobe is very prominent, broader than long, with the sides parallel at base, afterwards converging, giving a somewhat triangular shape to the lobe; rounded at apex, with a short median basal prolongation into the pygidium; with two large setae on the lobe and a small seta immediately laterad of the lobe on each side. Laterad of median lobe is a short, heavily chitinised incision, the two sides of the incision being fused. Laterad of this are two large setae and a cluster of some eleven long plates. Laterad of this a second incision with a minute pointed hyaline lobe and a group of two long setae and some twelve long plates. Laterad of this a third incision and a group of two setae and some eleven plates. Cephalad of this are four groups of similar plates decreasing in size towards the anterior end. Circumgenital pores in five groups and very numerous, at least 100 in the median group; they are situated in groups as in the genus *Aulacaspis*. Cephalad, mesad and caudad of the circumgenital pores the pygidium is more heavily chitinised. Numerous dorsal pores immediately cephalad of third and fourth groups of plates. Antennae widely separated, consisting of two long spines on a low spinous tubercle. Anterior and posterior spiracles with numerous glands.

On twigs of *Mallotus philippinensis*, causing slight swellings, 7. vii. 1914.

In the groups of plates this insect resembles *A. cucullus*, Gr. It also has affinities with *Morganella maskelli*, but differs from both in the presence of circumgenital pores, and in the median lobes being fused. On the whole, however, I think it is more nearly allied to *Howardia biclavis*, Comst.

Lepidosaphes erythrinae, sp. nov.

Female scale about 2 mm. long; exuviae at one end golden-brown; secretion very dark brown.

Male scale similar, but smaller; white in region of "hinge" and often caudad of "hinge."

Adult elongated; cephalothorax large, sides straight, tapering slightly towards the anterior end, which is rounded. Antenna consisting of a tubercle bearing 1 or 2 long setae; in one case one of the setae is deeply forked. Anterior spiracles with 1 or 2 parastigmatic glands, posterior one without such glands. A single pair of lobes, resembling somewhat in shape the lobes of *Howardia biclavis*, Comst.; they are prominent, somewhat triangular in shape, but not symmetrically so, the apex being much nearer to the mesal side; the mesal margin is slightly curved, with a notch near the apex; the lateral margin straight, minutely but distinctly serrated. A large triangular chitinous area extends into the pygidium from the base of each lobe. The other lobes are rudimentary, being represented by small serrated projections. Between the median lobes, a pair of plates, a pair of setae, and a small spinous process. There is also a small seta on the base of the median lobes. Laterad of the median lobes in the following order:—a plate; a gland-pore, with a short spine-like extension; two setae, the mesal one of which is situated over the serrated projection which occupies the position of second lobe; two long plates, the lateral one of which is associated with a gland pore; a gland pore; a seta; two long plates with a seta between them; two gland pores; a seta; two plates with a seta between them; one gland pore. The marginal pores are long and narrow. The segments in front of the pygidium bear two or three plates on their margins. The anus is situated cephalad of the median group of circumgenital pores. Circumgenital pores of two individuals: 4 (in a row), (6 and 6) (4 and 4); another specimen had (3) (6 and 5) (2 and 4). Dorsal pores small, in two bands on each side of pygidium, the mesal band being mesad of the lateral groups of circumgenital pores. The median lobes of the second exuvium are distinct and of the same shape as those of the adult.

On bark of *Erythrina* sp.

I know of no species of *Lepidosaphes* with which this insect can be confounded.

Lepidosaphes ambigua, n. sp.

Scale not observed. It had been blown away and the insects were left adhering to the twig. Adult insect several times as long as broad. Segments in front of the pygidium laterally distinct. Pygidium with prominent marginal pores. Body tapering cephalad to a blunt point. A short, triangular process projects on each side of the head cephalad of the mouth-parts, and the margin is there slightly bulged out. A pair of apically diverging plates between the median lobes. The marginal

pores are in pairs and open in an extension of the pygidial margin; they are elongate oval in shape. Circumgenital pores present. Pygidium with two pairs of lobes. The median lobes are separate, but close to each other, somewhat triangular in shape, but with the apex nearer to the mesal side. The mesal and lateral sides form an unbroken curve with the apex. The lateral side slopes towards the pygidium, turning sharply cephalad near the base; their margin is not notched. Laterad of the median lobes:—a seta; a plate; a triangular gland-pore projection, reaching as far caudad as does the second lobe; second pair of lobes, the mesal half of which is almost as large as the median lobe and of much the same shape, the lateral half being about half as broad, much shorter and rectangular in shape; a seta; two long plates; two gland pores; one seta; two plates; two gland pores; one seta; two plates; one gland pore.

On twigs of *Mesua ferrea.*

What may be the male scale of this insect occurs on the under surface of the leaves close to the midrib. The exuvium is yellowish at the pygidial end, the rest of the scale being greyish-white and uncarinated. The lobes of the exuvium are large, triangular, rounded at apex and projecting into the pygidium. Laterad of each lobe are two setae and a long plate, broad at its base and tapering rapidly towards the apex. Antenna with six segments.

Aonidia ferreae, sp. nov.

Female scale very black, shining. The first exuvium is situated usually just within the margin, sometimes more centrally, and is black with the apex yellowish; it is raised in the centre and striated. The rest of the scale consists of the second exuvium. The venter of the scale is white, and when the scale is removed a white deposit of wax is left on the twig.

It is a very difficult matter to obtain the adult female, owing to the fact that it is quite enclosed. The pygidium is hyaline, without lobes and provided with a fringe of about 24 long pectinae. The anus is situated about three times its own length from the margin of the pygidium. There are no circumgenital pores. The anus and vagina are superimposed. The female contains young with legs, lobes and mouth-parts well developed. The apex of the second exuvium bears three pairs of lobes, each longer than broad. The median pair is widest at the middle length. The median and second lobes have each a notch on the lateral side, the third has two notches or is minutely toothed; the median lobes may have a slight notch on the mesal side as well. There are two pectinae between the median lobes, two between median and second lobes, and three between the second and third lobes; the apices of the pectinae are on a level with the apices of the lobes and are frayed at the apex. Laterad of the third lobes are three pectinae followed by an acute lobe-like projection. The interlobular incisions are deep.

On twigs of *Mesua ferrea.*

Neolecanium cinnamomi, sp. nov.

Old scales dark brown in colour, younger scales greyish-brown and very inconspicuous against the bark of the branches on which they occur. The younger scale has a slight whitish mid-dorsal longitudinal ridge, and a submarginal wavy white

ridge, from which short whitish ridges run to the margin. Dorsal surface covered with a thin granular wax. Anal plates dark brown.

Broadly-oval in shape; length 4·75 mm., breadth 3·75 mm. Antennae 8-jointed; apex of fifth and segments distal of fifth much wrinkled; apical segment bearing a very long seta on the tip and three or four long hairs proximad of apex; the first, second, fifth, sixth and seventh also with setae, third and fourth without. Legs well developed, tibia longer than tarsus. Anal plates with straight mesal side, outer side an unbroken curve; and opening surrounded by a heavily chitinised band. Margin with a close-set series of stout, sharp setae; practically no stigmal notch; stigmatic seta longer and more gradually tapering than other setae; scattered parastigmatic pores between stigmal spine and the stigma. The derm is crowded with oval translucent areas, a small circular pore being associated with each; scattered among them are several circular highly chitinised pores. Anal ring to all appearance with ten long setae.

Insects recently settled down are elongated, whitish and highly granular, bearing two brown longitudinal bands enclosing a whitish area.

On bark of branches of Cinnamon, July 1914.

This insect is obviously closely related to Green's *Neolecanium crustuliforme*, from which it differs in its appearance, in its larger size and in the number of the antennal segments.

Parlatoria mesuae, sp. nov.

Female scale about 1 mm. long, long and narrow, black. The second exuvium is about twice as long as the first. A slight, white, marginal secretion. Ventral scale more or less complete, incomplete at posterior end.

The adult insect is long and narrow. The antennae consist of a tubercle, one or two short spines and a long straight or curved seta. No parastigmatic pores. No circumgenital pores. Apex of the pygidium occupied by a broad pore situated at the base of a deep notch and bounded on each side by a broad bi-lobed lobe-like pectina. Laterad of this is a hyaline lobe, notched on the lateral margin, and followed by a broad pore with bordering pectinae similar to those of the median pore. These follow two pectinae, a pore similar to the preceding pores, and cephalad of this several low serrated projections and two smaller pores. The pectinae end abruptly and their fringe is very short and ragged. A row of short triangular spines and small circular pores along the margin of the body, in some cases apparently absent cephalad of the level of the mouth-parts. Anus situated near the base of the pygidium. The body may contain young insects with well-developed legs, antennae and mouth-parts. The first exuvium has at least one pair of lobes; these are triangular, and well separated; at the base of each on the mesal side is a long seta directed cephalad. Laterad of these lobes a duplex lobe and several projections of the pygidium. Antenna five-segmented. Terminal segment with numerous transverse striae and several long setae. The second exuvium has two pair of hyaline lobes, each lobe much longer than broad, and notched on both margins and rounded at apex. The marginal pores are situated in deep, semicircular incisions, strongly chitinised on the margin; one between first and second lobes, one between second and third, and one between the sixth and seventh pectinae beyond the second lobes.

Two pectinae between the median lobes, two between median and second lobes, and about eight laterad of second lobes; groups of 3, 2, 2, 2 on margin cephalad of these. The pectinae are somewhat indefinite in shape, but some are distinctly two-pronged at the apex and chitinised on each side at the base.

On the edges of the leaves of *Mesua ferrea*; very inconspicuous.

When mounted the insect and exuviae are not infrequently folded longitudinally, so that the structure of the pygidium is difficult to make out.

In the broad, lobe-like pectinae that form the boundary of the notch containing the pore the insect bears a strong resemblance to species of *Fiorinia*. The puparium, however, is not quite closed and the broad, marginal pores suggest a relationship to the genus *Parlatoria*.

Ceronema koebeli, Gr.

I found what are probably insects of this species on the twigs of *Pithecolobium saman* at Peradeniya in June. The male scales are very conspicuous, being white, with the purplish insect shining through. Males were emerging. The costal vein stands out as a prominent band near the costal margin of the wing and stops abruptly before the apex; it looked dark brown in colour rather than " deep red " (Green). The male puparium is composed of 14 plates.

The males were observed in the act of copulation. The copulatory organ, which is curved, is inserted between the anal plates. During copulation the antennae are vibrated slightly and the female is patted with the first pair of legs. The male has some difficulty in orienting himself properly and seems to be guided at least partly by a tactile sense in the copulatory organ. The female at the time of fertilisation is flat and inconspicuous, owing to the fact that the underlying bark shows through. She is white or pinkish-white, and the white of the spiracular grooves is clearly visible. There is a median, dorsal, longitudinal rounded ridge, while the rest of the surface is corrugated. The eyes are black and are situated well caudad of the anterior margin. The insects are considerably longer than broad, oval and blunt at both ends. The anal plates are brownish or black. In this stage the labial curve of the anal plate is not waved as in Green's figure of the adult.

Adult insects were also present with eggs and larvae. The eggs are white or orange, the larvae white or reddish white with crimson spots.

The part of the dorsum that becomes denuded of wax in old specimens is the region of the anal scales; it is black and shining and the anal scales are very small.

The antenna in the specimens examined has eight segments, of which the third is the longest. The fifth segment bears a long slender hair which reaches well towards the distal end of the seventh segment. The polygonal cells of the derm look oval when the specimen has been subjected to prolonged boiling in KOH. The stigmatic spines are nine or ten in number. There seem to be ten setae on the anal ring, one or two of which, however, are slender.

The insect is subject to the attack of Hymenopterous parasites. As many as four exit holes were observed in one scale. Emergence had taken place before the test had been fully developed.

The caterpillars of *Spalgis epius* were feeding inside the ovisac. They are of a dark green colour, bear tufts of hair, and are coated with the eggs, white wax, etc., of the scale.

There are four pairs of abdominal and a pair of anal forelegs ; the hooks are situated in a longitudinal row on the mesal side.

COLLECTIONS RECEIVED.

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Dr. W. M. Aders :—3 Oestridae, 1 slide of Siphonaptera, 1 Hymenopteron, 4 Coleoptera, 4 species of Coccidae and 67 Mallophage ; from Zanzibar.

Rev. Jas. Aiken :—1 Flea, 7 Cimicidae, 5 Anoplura and 25 Ticks ; from Berbice, British Guiana.

Mr. T. J. Anderson, Chief of Entomological Division :—3 *Haematopota*, 12 other Diptera, 2 Hymenoptera, 51 Coleoptera, 15 Lepidoptera, 4 Planipennia, 15 spp. of Coccidae, 22 other Rhynchota and 8 Orthoptera ; from British East Africa.

Mr. E. Ballard, Government Entomologist :—138 Culicidae, 153 other Diptera and 7 puparia ; from Coimbatore, India.

Mr. G. E. Bodkin, Government Biologist :—2 *Chrysops*, 1 *Rhinomyza*, 7 *Tabanus*, 2 Fleas, 27 Hymenoptera, 49 Termites, 56 Coleoptera, 149 Lepidoptera, 3 Cimicidae, 10 other Rhynchota, 5 Orthoptera, 27 Anoplura, 34 Mallophaga, 3 slides of Thrips, 15 Ticks, 1 Spider and 2 tubes of Intestinal Worms ; from British Guiana.

R. Mr. J. ~~A.~~ Bovell, Superintendent of Agriculture :—4 Diptera and 17 Lepidoptera ; from Barbados.

Mr. E. C. Chubb, Curator of the Durban Museum :—312 Culicidae, 5 *Haematopota* and 214 other Diptera ; from Natal.

Mr. E. B. Connell :—5 Diptera, 206 Hymenoptera and 63 Coleoptera ; from Trinidad.

Dr. J. B. Davey, M.O. :—16 Culicidae, 13 *Chrysops*, 4 *Haematopota*, 7 *Tabanus*, 149 other Diptera, 63 Hymenoptera, 218 Coleoptera and 1 larva, 1 Cimicid, 97 other Rhynchota, 8 Orthoptera and 15 Ticks ; from Mlanje, Nyasaland.

Dr. G. Davies :—22 Culicidae ; from the British Solomon Islands.

Mr. E. Dayrell, District Commissioner :—22 *Tabanus* and 4 *Glossina* ; from Opobo, Southern Nigeria.

Mr. D. Dibben :—1 *Haematopota*, 1 *Tabanus*, 1 *Cordylobia*, 16 other Diptera ; from Estcourt, Natal.

Dr. A. G. Eldred, M.O. :—59 Culicidae, 2 *Chrysops*, 19 *Haematopota*, 10 *Tabanus*, 4 *Glossina*, 2 *Stomoxys*, 13 other Diptera and 1 Chelifer ; from Karonga, Nyasaland.

Mr. J. H. J. Farquhar, Conservator of Forests :—4 *Tabanus* and 12 *Glossina* ; from Benin City, Southern Nigeria.

Mr. C. Fuller, Asst. Chief of Division of Entomology :—22 Diptera, 2 Hymenoptera, 142 Coleoptera, 4 Rhynchota, 22 Orthoptera, and 10 Millipedes ; from Pretoria, South Africa.

Dr. Lewis Gough, Government Entomologist :—113 Hymenoptera, 8 Lepidoptera, 8 Odonata, 7 Planipennia and 6 Rhynchota ; from Cairo, Egypt.

Mr. C. C. Gowdey, Government Entomologist :—1 *Haematopota*, 4 *Tabanus*, 5 *Glossina*, 3 Hippoboscidae, 34 other Diptera, 222 Hymenoptera, 1377 Coleoptera, 5 Lepidoptera, 12 species of Coccidae, 498 other Rhynchota, 111 Orthoptera, 140 Thrips, 9 Ticks and 5 Millipedes ; from Entebbe, Uganda.

Imperial Department of Agriculture for the West Indies :—A large number of *Polistes* and nests, 15 Curculionidae from cotton, 15 moths and 8 pupae ; from West Indies.

Mr. F. P. Jepson, Government Entomologist :—85 Culicidae ; from Suva, Fiji.

Mr. H. H. King, Government Entomologist :—5 Oestridae ; from Anglo-Egyptian Sudan.

Mr. F. A. Knowles, Provincial Commissioner :—118 Ticks ; from Uganda.

Dr. W. A. Lamborn, Government Entomologist :—14 *Phlebotomus*, 1 *Tabanus*, 13 *Simulium*, 41 other Diptera, 167 Hymenoptera, 221 Coleoptera and 5 larvae, examples of damage done by Coleoptera, 12 Lepidoptera, 3 species of Coccidae, 35 other Rhynchota, eggs of a Pentatomid bug, 3 Orthoptera, 12 Ticks and a number of Mites ; from Ibadan, Southern Nigeria.

Captain A. O. Luckman, Asst. District Commissioner :—2 *Haematopota*, 1 *Tabanus*, 10 Hippoboscidae, 172 other Diptera, 1 Flea, 178 Hymenoptera, 912 Coleoptera, 12 Lepidoptera, 112 Rhynchota, 73 Orthoptera, 240 Ticks and 2 other Arachnids ; from S. Masai Reserve, British East Africa.

Dr. R. E. McConnell, M.O. :—1 *Culicoides*, 15 Culicidae, 11 *Haematopota*, 9 *Tabanus*, 15 *Glossina*, 2 *Stomoxys*, 1 *Lyperosia*, 68 other Diptera, 15 Hymenoptera, 4 Odonata, and 16 Ticks ; from Fort Portal, Uganda.

Dr. Harold Macfarlane, Government Bacteriologist :—8,133 Culicidae ; from Hong Kong, China.

Dr. J. W. Scott Macfie, W.A.M.S. :—A number of *Culicoides* and 1 Millipede ; from Southern Nigeria.

Dr. A. Morstatt :—2 *Simulium* ; from German East Africa.

Mr. J. C. Moulton :—215 Culicidae ; from Kuching, Sarawak.

Mr. S. A. Neave :—3 *Phlebotomus*, 60 Culicidae, 134 *Chrysops*, 214 *Haematopota*, 451 *Tabanus*, 117 *Silvius*, 417 Tabanid larvae, 15 *Glossina*, 11 *Simulium*, 17 Hippoboscidae, 134 examples of prey of the Asilid, *Promachus fasciatus*, 111 other Asilids and prey, 2 Asilid larvae, 142 other Diptera, 64 Parasitic Hymenoptera and hosts, 1,361 other Hymenoptera, 4,266 Coleoptera and 22 larvae, 220 bred Moths, 11 larvae, 52 cocoons, 5,727 other Lepidoptera, 1 Embiid, 1 Bittacid, 1 Caddis-fly, 1 May-fly, 1 Stone-fly, 1 Dragon-fly and prey, 42 Cimicidae, 849 other Rhynchota, 2 Mantids and prey, 211 other Orthoptera, 60 Mites and 467 Ticks ; from Nyasaland and Portuguese East Africa.

Prof. G. H. F. Nuttall, F.R.S. :—A number of Diptera ; from British West Indies.

Dr. J. E. S. Old, M.O. :—28 Culicidae, 13 *Haematopota*, 3 *Tabanus*, 3 Hymenoptera, 42 Coleoptera, 39 Rhynchota, 9 Orthoptera, 1 Spider, 1 Scorpion and a number of Intestinal Worms ; from Port Herald, Nyasaland.

Lieut. G. St. J. Orde-Browne, Asst. Dist. Commissioner :—6 Culicidae, 1 *Pangonia*, 3 *Haematopota*, 98 other Diptera, 50 Hymenoptera, 7 Coleoptera, 1 Caddis-Fly 8 Rhynchota, and 2 Orthoptera ; from Chuka, British East Africa.

Dr. H. B. Owen, M.O. :—7 *Glossina* and 11 Hippoboscidae ; from Uganda.

Dr. J. S. Pearson, M.O. :—36 *Tabanus* and 17 *Glossina* ; from Kaballa, Sierra Leone.

Dr. G. J. Pirie, M.O. :—53 Culicidae, 28 *Tabanus*, 23 *Glossina*, 1 Hippoboscid, 1 *Auchmeromyia*, 5 other Diptera and 50 Ticks ; from Northern Nigeria.

Mr. A. Rutherford, Government Entomologist :—4 *Phlebotomus*, 20 Culicidae, 1 *Chrysops*, 2 *Haematopota*, 1 *Tabanus*, 1 Asilid and Prey, 38 other Diptera, 36 Hymenoptera, 123 Coleoptera, 52 Lepidoptera, 113 Rhynchota, 1 Orthopteron, 185 Thrips and 200 Ticks ; from Peradeniya, Ceylon.

Mr. H. Silberrad, District Resident :—22 *Haematopota* and 28 *Tabanus* ; from Chinteche, Nyasaland.

Dr. B. Spearman, M.O. :—1 *Haematopota*, 12 *Tabanus*, 1 *Auchmeromyia*, 2 other Diptera ; from Gulu, Uganda.

Dr. H. S. Stannus, M.O. :—38 Culicidae, 14 *Tabanus*, 1 *Auchmeromyia*, 1 Hippoboscid, 3 Asilids and Prey, 52 other Diptera, 116 Hymenoptera, 203 Coleoptera, 119 Lepidoptera, 4 Odonata, 2 Planipennia, 1 *Panorpa*, 78 Rhynchota, 4 Orthoptera and 1 Arachnid ; from Zomba, Nyasaland.

Dr. H. Swale :—7 *Dorcaloemus*, 2 *Haematopota*, 1 *Tabanus*, 12 other Diptera and 7 Hymenoptera ; from Lonely Mine, Southern Rhodesia.

Sir A. Theiler :—6 larvae of *Dermatoestrus strepsicerontis* ; from Pretoria.

Mr. R. C. Wood :—2 Ticks ; from Chilanga, Northern Rhodesia.

Mr. R. C. Wroughton :—1 *Chrysops*, 7 *Haematopota*, 6 *Tabanus* and 813 other Diptera ; from Estcourt, Natal.

NEW AND LITTLE-KNOWN EAST AFRICAN CULICIDAE.

By F. W. Edwards.

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Collections recently received by the Imperial Bureau of Entomology, chiefly from Natal, have brought to light several interesting new forms in this group of flies, and their study has yielded certain unlooked for results which it appears desirable to place on record, together with descriptions of the new species, the types of which have been presented by the Bureau to the British Museum. The opportunity has been taken of publishing revised keys to the African species of *Banksinella* and *Taeniorhynchus*.

Genus Banksinella, Theo.

1.	Costa partly white or yellowish	2
	Costa entirely dark	3
2.	Costa white on apical third or half; proboscis unbanded; hind tibiae mostly dark; dorsum of thorax almost all white; abdomen banded	*albicosta*, Edw.
	Costa with two yellow spots; proboscis with a yellow median band; hind tibiae with golden-yellow markings; abdomen unbanded	*punctocostalis*, Theo
3.	Wings entirely without yellow scales; no well-defined yellow border to thorax; abdomen unbanded	*fuscinervis*, Edw.
	Wings with yellow scales present, at least on the bases of the first and fifth longitudinal veins; thorax normally with a well-defined yellow border	4
4.	First longitudinal vein, and the lower branch of the fifth, yellow-scaled almost to their tips; hind tibiae with a small apical yellowish spot; middle tibiae rather conspicuously yellow on the hinder side, especially towards the tip	*luteolateralis*, Theo.
	First longitudinal vein dark-scaled beyond the base of the third vein	5
5.	Hind tibiae with a distinct pale spot at the apex; proboscis with a more or less distinct yellow ring in the middle; abdomen unbanded, at least on the basal segments	6

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Hind tibiae without a distinct apical pale spot, though they may be pale beneath throughout their whole length; proboscis unbanded; abdomen distinctly banded .. .. .. *lineatopennis* (Ludlow)

6. Male claspers hairy at the tip, and bearing a stout blunt-ended spine .. .. .. *palpalis* (Newst.)

Male claspers not hairy at the tip, bearing only a long, curved, tapering spine .. .. *taeniarostris*, Theo.

Of the above seven species, four (*punctocostalis*, *fuscinervis*, *palpalis* and *taeniarostris*) are, so far as we know at present, confined to West Africa, and two (*albicosta* and *luteolateralis*) to East Africa.

B. albicosta, Edw.

This was described by me (Bull. Ent. Res., iv, p. 47) as a variety of *B. luteolateralis*. There is very little doubt, however, that it should stand as a distinct species. No additional specimens have been received.

B. luteolateralis, Theo.

Theobald's original series consisted of specimens from Durban (Natal), Salisbury (Rhodesia), and the Malay States, a female from Durban being selected as the female type and a specimen from Salisbury being chosen to represent the male. Recently I have re-examined these specimens and found that Theobald had made the error of associating two forms under one name and placing a type label on a specimen of each. In this case there can be no doubt that the specimen on which his description was mainly based, was the female from Durban, and unfortunately this is very much the rarer of the two forms, being still unknown outside the original locality, while the other form (*B. lineatopennis*) is a common and widespread insect. There is room in this case for difference of opinion as to whether the two should stand as species or varieties, but as I have seen no African specimens at all intermediate, I prefer to regard them as species, though apart from the characters given in the key there is little difference between the two.

A good series of females, and one male of the true *B. luteolateralis* have recently been received from Durban (*L. Bevis* and *C. B. Cooper*). The male genitalia are extremely similar to those of *B. lineatopennis*, but the spine at the tip of the claspers appears to be thicker and more blunt-ended.

B. lineatopennis, Ludlow.

I have previously given this as a synonym of *B. luteolateralis*, but it proves to be distinct by the characters just mentioned. It is widely spread in both the Ethiopian and Oriental regions, but in Africa (where it is by far the most abundant member of the genus) it is much commoner in the southern and eastern portions of the continent. The species is rather variable: sometimes the yellow scales of the thorax are replaced by whitish ones (vars. *pallida* and *albothorax*) and sometimes there are a few or numerous yellow lateral scales on the second and fourth longitudinal veins.*

* Carter (Ann. Trop. Med., vii, p. 583, 1913) has given a good figure of the genitalia of this form, and also of *B. palpalis*.

Genus Ochlerotatus, Arrib., Edw.

O. hirsutus, Theo.

Theobald (Union of S. Afr., Second Rept. Vet. Research, p. 328) has criticised my statement that his *Culex hirsutum* and *C. transvaalensis* are one and the same species. I have re-examined the specimens, and find no reason to modify my previous opinion, except in one particular. The male and female types of *C. hirsutum* belong to different species, and it was perhaps owing to his confusion of the two that Theobald was unable to agree with my findings. The female type must be taken as the type of the species, the male (the specimen figured in Bull. Ent. Res. ii, p. 249) being really *O. nigeriensis* (Theo.). These species, as previously pointed out, can be readily distinguished by the colour of the wing-scales, but for their better definition, I now give figures of the male genital claspers of each (fig. 1, *d* and *e*).

Unrecorded localities for *O. hirsutus* are: British East Africa: Moyale, 1. v. 1913 (*Dr. G. R. H. Chell*); Portguese West Africa: Bihé (*Dr. C. Wellman*).

O. chelli, sp. nov.

♀. *Head* clothed with yellowish-ochreous narrow curved and upright forked scales, only a few flat ones at the sides. Basal joint of antennae with small flat ochreous scales. Palpi and proboscis entirely black-scaled. *Thorax* with the integument dark brown, clothed with light ochreous brown scales at the sides, darker brown ones in the middle. Scutellum with narrow pale ochreous scales. *Abdomen* marked somewhat as in *O. dorsalis*: it is dark brown, with ochreous basal bands on each segment and with a continuous median longitudinal stripe of the same colour; towards the apical margins of the fifth, sixth and seventh segments this stripe broadens out considerably. Scales of venter ochreous. *Legs*: femora and tibiae strongly mottled with dark brown and pale ochreous scales, the femora entirely pale on their inner or posterior surfaces, except towards the tip. Tarsi of all the legs dark brown, the first joint with a fairly broad but ill-defined pale ring at the base, second and third joints with very narrow basal pale rings, fourth joint with a mere trace of such a ring; fifth entirely dark. Claws toothed (hind pairs missing). *Wings* with dark brown scales, and a few scattered pale ones on the median series; scales of lateral series linear. Upper fork-cell with its base nearer the apex of the wing than the lower.

Length about 5 mm.

British East Africa: Dido, 30. xi. 1911 (*Dr. G. R. H. Chell*), 3♀.

These specimens answer in many respects to Neveu-Lemaire's description of *Taeniorhynchus africanus*, but there are several discrepancies, and on the whole it seems most probable that Neveu-Lemaire's species was only *O. dorsalis*, some disagreement notwithstanding. The present species is named in honour of the collector, the only person who has up to the present collected mosquitos in this interesting district of British East Africa.

O. bevisi, sp. nov.

♀. *Head* clothed mainly with pale ochreous scales, but the usual spot of dark brown ones is present on each side. Scales narrow and curved in the middle and round the eyes, broad and flat at the sides, the latter reaching not far short of the

middle line. Palpi blackish brown, with creamy tips. Proboscis dark brown at the base and apex, ochreous in the middle two-thirds beneath and at the sides. First two joints of antennae with small flat ochreous scales, the basal joint ochreous. *Thorax* dark brown, clothed with narrow brown and ochreous-brown scales without any definite pattern. Scutellar scales narrow. Flat ochreous scales on the pleurae. *Abdomen* dark brown, each segment with whitish basal lateral spots and median bands not connected with the spots. Venter whitish ochreous, the apical margins of the apical segments black. *Legs:* femora without any intersprinkling of light and dark scales, pale knee-spots very distinct. Tibiae blackish, on the front and middle legs largely pale on their outer and posterior faces; hind tibiae with a well-marked pale spot at the apex on the outside, which is about equal in length to the breadth of the tibia. Tarsi blackish; on all the legs there is a narrow ochreous ring embracing the tip of the first and the base of the second joint, and a still narrower ring embracing the tip of the second and the base of the third. All the claws toothed. *Wings* clothed with dark brown scales, those of the lateral series linear. Bases of fork-cells level.

Length about 5 mm.

NATAL: Umbilo, Durban; 1 ♀, 16. v. 1914 (type); 2 ♀, 13. ix. 14 and 1 ♀, 25. ix. 1914 (*L. Bevis*).

Readily distinguished from all other African species by the tarsal markings. Although small pale rings are present on these, the species seems to belong to the *dentatus*-group.

O. albocephalus, Theo.

A good series of specimens of both sexes of this species have been received from Durban (*E. C. Chubb* and *L. Bevis*). Previously it was only known in the male sex from West Africa. It proves to be of considerable interest owing to a marked difference of scale characters between the two sexes. In the male, the flat scales of the head extend up to the middle line in front, while in the female the middle area of the head is clothed with narrow scales; the scutellar scales in the male are broad, in the female narrow. No such sexual difference has been noticed in any other mosquito.

As I have previously pointed out (Bull. Ent. Res. iii, p. 21), the figure which Theobald gives (Mon. Cul. v, p. 206) as representing the male genitalia of *O. punctothoracis*, really depicts those of *O. albocephalus*. This figure, however, is by no means accurate, and a fresh one is therefore given herewith (fig. 1, *c*).

The female *O. albocephalus* can be distinguished from *O. quasiunivittatus*, which it otherwise closely resembles, by the much larger white spot at the apex of the hind tibiae, which is quite twice as long as the width of the tibia.

O. quasiunivittatus, Theo.

This species occurs side by side with *O. albocephalus* in Durban, a few females having been sent in by Mr. Chubb. What appears to be a good specific character, is the size of the pale spot on the hind tibia; this is very distinct, and is about equal in length to the diameter of the apex of the tibia, *i.e.* it is about as broad as long. The thoracic scaling is like that of the female *O. albocephalus*. The fact that this

species and *O. dentatus* differ markedly in the male genitalia has already been referred to, and the present opportunity is taken of figuring this difference (figs. 1, *a*, *b*). There are other well-marked genital distinctions between *O. quasiunivittatus* and *O. dentatus* besides those in the claspers, but as the latter are most readily seen (being usually visible even in a dried specimen), they alone have been figured.

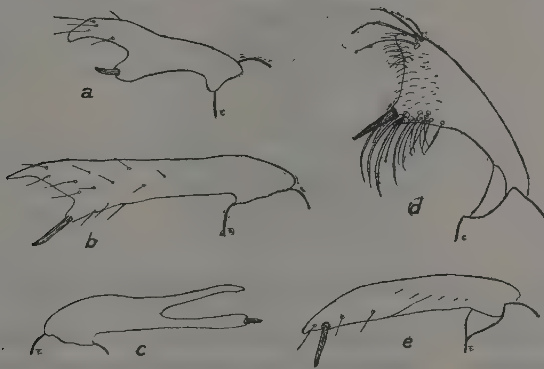

Fig. 1. Male claspers of :—(*a*) *Ochlerotatus quasiunivittatus*, Theo. ; (*b*) *O. dentatus*, Theo. ; (*c*) *O. albocephalus*, Theo. ; (*d*) *O. nigeriensis*, Theo. ; (*e*) *O. hirsutus*, Theo.

O. dentatus, Theo.

This species also apparently occurs at Durban together with *O. albocephalus* and *O. quasiunivittatus*, though only female specimens have been received. It seems to differ from the other two in the thorax being darker, the pale scales having a tendency to a linear arrangement, and in the very small pale spot at the tip of the hind tibiae, which is never more than about half as long as broad. The best specific character is, however, the structure of the male genitalia (fig. 1, *b*). The species has been received from various localities in British East Africa.

O. pembaensis, Theo.

Aëdes pembaensis, Theo., Mon. Cul. ii, p. 235 (1901).
Skusea pembaensis, Theo., Mon. Cul. iii, p. 291 (1903).
Verrallina ? pembaensis, Theo., Mon. Cul. v, p. 495 (1910).
Howardina ? pembaensis, Edw., Bull. Ent. Res. iii, p. 13 (1912).
Aëdes (*Skusea*) *pembaensis*, Edw., Bull. Ent. Res. iv, p. 49 (1913).

As indicated above, this species has undergone many nomenclatorial vicissitudes, and it is not certain that it has even yet found a final resting-place, as it is one of those intermediate forms which make the classification of the *Aëdes* group so difficult. Specimens representing both sexes have lately been sent in by Dr. W. M. Aders from Zanzibar, where the larvae were found living in stagnant water, 31. iii. 1914. The male palpi are as long as the proboscis, and though the last two joints are scarcely swollen, they are hairy and bent downwards as usual in *Ochlerotatus*, so that in spite of the simple claws of the female the species is probably better placed

in *Ochlerotatus* than in *Stegomyia* or *Aëdes*. The male genitalia offer little assistance in classifying the insect, since their structure is so aberrant. The rather small but curiously complex hypopygium is almost hidden by the greatly developed seventh sternite (fig. 2).

Fig. 2. Male armature of *Ochlerotatus pembaensis*, Theo.

The Oriental species, *O.* ("*Stegomyia*") *micropterus*, Giles, would appear to be a near ally of *O. pembaensis*, as it resembles it in everything except the male genitalia and the more brownish tint; in *O. micropterus* the male genitalia and also the larvae (which have been found by Major James, living in bamboo stems in Ceylon) approach closely to the ordinary *Ochlerotatus* type.

Genus Taeniorhynchus, Arrib.

1.	Tibiae all black or violet-black	2
	Tibiae yellow, often with black rings	3
2.	Violet-black species, thorax with a patch of whitish scales in front	*metallicus*, Theo.
	Thorax shining black, abdomen golden-yellow	*nigrithorax*, Theo.
3.	Hind tibiae entirely yellow	4
	Hind tibiae with a black ring in the middle	6
4.	Wing-scales and scales on palpi in both sexes all yellow	*auripennis*, sp. n.
	Wings with some dark scales; tips of palpi black-scaled	5
5.	Wings with dark scales almost confined to the sixth longitudinal vein	*microannulatus*, Theo.
	Fourth, fifth and sixth veins mainly dark-scaled	*chubbi*, sp. n.
6.	Golden-yellow species; costa entirely yellow; dark scales on wings few or absent..	7
	Darker species; costa with at least a few dark scales; dark scales on wings numerous	9

7. Claspers of male genitalia simple (Nyasaland) ..	*chrysosoma*, sp. n.
Claspers of male genitalia with a conspicuous membranous lobe	8
8. Lobe of claspers moderate, moderately hairy (Uganda, etc.)	*aurites*, Theo.
Lobe of claspers enormous, very hairy (Natal)	*aureus*, sp. n.
9. Thorax clothed (often sparsely) with small golden-brown scales; scutellum bare; wings with dark and light scales evenly intermixed	10
Thorax more densely clothed with pale golden scales; scutellum thinly scaled; wings with dark and light scales arranged more in patches	11
10. Thoracic integument light brown in the middle of the mesonotum and scutellum, darker brown at the sides and in front ..	*fuscopennatus*, Theo.
Integument of mesonotum, scutellum and postnotum entirely black or blackish brown	*cristatus*, Theo.
11. Costa entirely dark; thorax without a distinct golden-yellow patch in front ..	*versicolor*, Edw.
Costa mainly yellow; thorax with a distinct patch of pale golden scales in front	12
12. Fork-cells very long; male genital claspers much dilated just before the tip	*annetti*, Theo.
Fork-cells somewhat shorter; male genital claspers not dilated	*maculipennis*, Theo.

The eight species from *auripennis* to *cristatus* are all very closely related, and some of them should perhaps rank as varieties, but appear to be distinct in one way or another.

T. metallicus, Theo.

This species proves to have a very wide distribution. Specimens have been received from British East Africa (Lumbwa district, *C. M. Dobbs*, and Uchweni Forest, *S. A. Neave*), Nyasaland (Karonga, *Dr. A. G. Eldred*) and Natal (Durban, *L. Bevis*). It is very probable that the species occurs also in the Philippine Islands, since some female specimens sent me by Miss Ludlow as her *T. aureosquamatus* seem to differ only from African specimens in their smaller size. Specific differences may, however, be revealed when the male is discovered in the Philippines.

T. auripennis, sp. nov.

An entirely yellow species, differing from *T. aurites* in the absence of the black ring in the middle of the hind tibiae, the narrower black rings on the joints of the hind tarsi, and the entirely yellow palpi. The male genitalia seem hardly

distinguishable from those of *T. aurites* or from those of *T. fuscopennatus*, though both of these species are distinct enough from *T. auripennis* and from one another in coloration.

UGANDA: Entebbe (*Capt. E. D. W. Greig, I.M.S.*), 1 ♂ 1 ♀ (types); SUDAN: Bahr-el-Jebel (*Dr. A. Balfour*), 2 ♀.

The specimens originally stood in the British Museum collection as *T. aurites*; subsequently I determined them as *T. microannulatus*, recording them as such in Bull. Ent. Res. iii, p. 26.

T. chubbi, sp. nov.

An almost uniformly yellow species, like the preceding; there are, however, black scales on the tips of the palpi, the proboscis, and the tarsal joints, and scattered black scales on the femora; on the wings the scales of the fourth, fifth and sixth longitudinal veins are mostly black, so that to the naked eye the wing appears dark on the lower basal part and yellow elsewhere; on the remaining veins (except the costa) there are a few dark scales. The scales of the hind tibiae are appressed. The male genitalia closely resemble those of *T. aurites* except in the claspers (fig. 3, *a*), which are relatively larger and have a larger membranous lobe, and also are more hairy towards the tip. The clasper of *T. aurites* is shown for comparison (fig. 3, *b*).

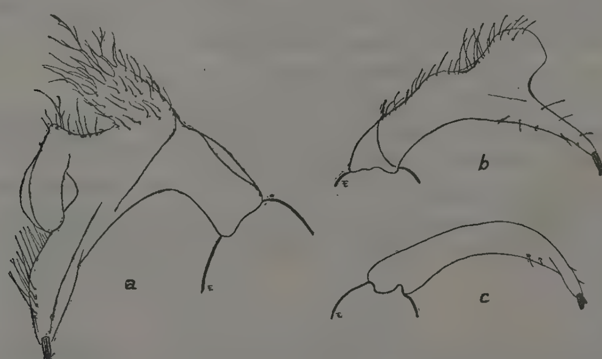

Fig. 3. Male claspers of:—(*a*) *Taeniorhynchus chubbi*, sp. n.; (*b*) *T. aurites*, Theo.; (*c*) *T. chrysosoma*, sp. n.

NATAL: Umbilo, Durban, under mango trees and in grass near water, September 1914 (*L. Bevis*); 6 ♂ (including type) 2 ♀.

Named in honour of Mr. E. C. Chubb, Curator of the Durban Museum, who has greatly added to our knowledge of Natal Diptera, and through whom these specimens were received.

The much darker wings should be sufficient to distinguish this form specifically from *T. microannulatus*; no more satisfactory distinction can be pointed out, since the male of the latter is unknown.

T. chrysosoma, sp. nov.

Closely resembles *T. aurites*, except in the male genital claspers (fig. 3, *c*), which have no trace whatever of a membranous lobe. The scales on the hind tibiae seem to be more closely applied than in *T. aurites*, but this difference may not be constant.

Nyasaland: Karonga, ii. 1912 (*Dr. A. G. Eldred*), 2 ♂ (including type) 1 ♀.

T. aureus, sp. nov.

Appears to differ only from *T. aurites* in the male genital claspers, which are extremely similar to those of *T. chubbi*, differing only in the absence of the tuft of hairs just before the apex.

Natal: Umbilo, Durban, in bush and in grass near water, 6.30-7 a.m., 24 and 25. ix. 1914 (*L. Bevis*), 7 ♂ (including type), 6 ♀.

DIAGNOSES OF NEW BORNEAN CULICIDAE.

By F. W. Edwards.

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The following are preliminary diagnoses of new species of Culicidae from Kuching, Sarawak. The specimens were received from Mr. J. C. Moulton, and either were collected by the donor, or formed part of the old collection of mosquitos in the Sarawak Museum, which was for the most part obtained in the neighbourhood of Kuching by Messrs. J. Hewitt and J. E. A. Lewis. The types are all in the British Museum.

Armigeres confusus, sp. n.

Coloration as in *A. jugraensis* (Leic.)* but the seventh sternite in both sexes is clothed with black instead of white scales. Basal lobes of side-pieces of male genitalia with a tuft of hairs, whereas in *A. jugraensis* there is only a single bristly spine in this position.

7 ♂ 4 ♀ (*Moulton*, *Hewitt* and *Lewis* ?).

Armigeres kuchingensis, sp. n.

Coloration and scale characters as in *A. hybridus*, Edw. Male genitalia: claspers strongly curved; basal lobes of side-pieces with three plates, which are much narrower than those of *A. hybridus* and almost spine-like; in addition there are three short bristles in one row with the three spine-like plates.

2♂ 6 ♀, third mile Rock Road, 24 and 27. vii. 1914, females biting collector; 1♀, presumably this species, Kuching Reservoir, 30. vii. 1914 (*J. C. Moulton*).

Aëdes ? curtipes, sp. n.

Colour almost uniformly dark brown, only varied by the whitish basal lateral spots on segments 2-7 of the abdomen, and the somewhat lighter under sides of the femora. Head and scutellum with broad flat scales. Thorax rather densely bristly. Legs somewhat shorter and stouter than in other members of the genus; the front metatarsi noticeably shorter than the remaining joints taken together; claws all simple. Lateral vein-scales ovate-lancedate, blunt at the tip. Fork-cells somewhat longer than their stems, the upper one with its base a little nearer to the base of the wing than that of the lower.

Length just over 3 mm.

2♀ (including type) from the old Sarawak Museum collection; also 1 ♀ from Membakut, N. Borneo (*Dr. R. Roper*) and 1♀ from Klang, Selangor (*Dr. G. F. Leicester*).

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* I find that I was mistaken in giving *A. jugraensis* as a synonym of *A. joloensis* (Ludlow). Specimens of the latter sent me by Dr. Ludlow evidently represented only a slight colour variation of *A. obturbans*.

An obscure species; distinguished from *Stegomyia amesii*, Ludlow (= *S. fusca*, Leic.) by the broader wing-scales and thicker legs; from *Mimomyia minima* (Ludlow) by the longer fork-cells, more pointed abdomen and shorter second antennal joint; and from *Aëdes butleri* and other similarly coloured species by the somewhat broader wing-scales and thicker legs.

Culex mimulus, sp. n.

Differs from *C. mimeticus*, Noé, as follows:—it is, on the average, rather smaller; the third longitudinal vein is usually entirely dark-scaled, though the middle portion is sometimes (especially in the female) pale-scaled (in *C. mimeticus* the third vein is always pale-scaled except at the base and tip). Male genitalia closely resembling those of *C. vishnui*, Theo., the second plate of the harpagones having five divisions at its tip, arranged something like the spread fingers of a hand (in *C. mimeticus* these plates are of a different shape and have only two divisions at their tips).

Numerous specimens in the old Sarawak Museum collection; others collected by Mr. J. C. Moulton.

This seems to be the representative in the Oriental region of the Palaearctic *C. mimeticus*. Probably all specimens recorded as *mimeticus* from the Oriental region are this species; at any rate the British Museum possesses specimens from the Malay States, Ceylon and India, while those from Hong Kong, North India, Palestine and Cyprus are the true *mimeticus*.

Culiciomyia spathifurca, sp. n.

Differs only from *C. fragilis* in the male genitalia. The side-pieces are larger and more rounded; the claspers are nearly straight, somewhat spatulate towards their tips, while from near the base on the inner side of each arises a long, tapering, smooth process, sinuous before its tip, as long as the clasper proper. In *C. fragilis* the clasper is bent in the middle, pointed and devoid of the basal process. There are other small differences which need not be described since that in the claspers is as striking as in any two species of mosquitos.

1 ♂, in house, Kuching, 22. vii. 1914 (*J. C. Moulton*). A female from Kuching Reservoir, 30. vii. 1914, may be either this species or *C. fragilis*.

Uranotaenia brevirostris, sp. n.

Head clothed with dark brown scales, proboscis and palpi black, the proboscis hardly more than two-thirds as long as the abdomen. *Thorax* yellow-ochreous, with numerous long black bristles and with scattered small pale yellowish scales; scutellum with small flat pale brown scales; pleurae unscaled; no line of flat scales in front of the wing-base. *Abdomen* dark brown dorsally, yellowish ventrally, without spots or bands. *Legs* normal in structure, uniformly clothed with dark brown scales. *Wings* with normal venation; scales brownish, much darker towards the costa; lateral vein-scales ovate.

Eighteen specimens, including both sexes. Bred from pitcher plant, 1907 (*J. Hewitt*).

Differs from *U. moultoni*, Edw., in the yellow instead of black scales on the mesonotum, and in the somewhat less striking contrast in colour between the thorax and abdomen.

Uranotaenia obscura, sp. n.

Differs from the preceding in having the integument and scales almost uniformly dark brownish, only the pleurae and the under side of the abdomen being somewhat lighter.

Fourteen specimens, including both sexes, from the old collection of the Sarawak Museum.

Rachionotomyia nepenthis, sp. n.

Head with the flat scales dark brown or dark bluish-grey, according to the incidence of light; a narrow border round the eyes paler, but not distinctly blue. Clypeus bare. Proboscis barely longer than the abdomen, but quite thin at the tip. *Thorax* as in *R. aranoides*, thickly clothed with dark brown, broadly spindle-shaped scales; prothoracic lobes and the space on the mesonotum behind them clothed with dark brown scales; pleurae and coxae with flat silvery-white scales. *Abdomen* with the dorsum dark brown, with a continuous lateral light brownish stripe, which is not quite even in width but broadens out somewhat on the hind margin of each segment; venter ochreous. Male genitalia resembling those of *R. aranoides*, but the appendages of the ninth sternite with five (not three) more slender spines. *Legs* dark brown, under sides of femora ochreous. Front and middle claws of male very unequal, on the front legs the larger claw bears a distinct tooth; hind tarsi with a single minute claw. *Wings* with dark brown scales; the scales in the lateral series almost linear; long lateral scales present on the upper margin of the basal part of the fourth longitudinal vein. Base of upper fork-cell a little nearer the apex of the wing than that of the lower.

Length 3 mm.

4 ♂ 2 ♀, "Bred from pitcher plant, Nov. 1907" (*? J. Hewitt*).

Differs from *R. aranoides* in the shorter proboscis, brown and not white-scaled patch behind the prothoracic lobes, slightly irregular lateral abdominal stripe and the absence of one of the claws on the hind legs.

Rachionotomyia proxima, sp. n.

Closely resembles *R. coeruleocephala* (Leic.), differing as follows:—Mesonotum with yellow instead of black scales; larger claw of front legs of male perfectly simple, not notched; bristles at the tips of the appendages of the ninth sternite of the male longer.

1 ♂ (type) 2 ♀, from old collection of Sarawak Museum; also 1 ♂ from Ulu Klang, Selangor (*Dr. G. F. Leicester*) and 1 ♂ from Ulu Gombak, Selangor (*Dr. A. T. Stanton*).

THE TABANIDAE OF SOUTHERN NYASALAND WITH NOTES ON THEIR LIFE-HISTORIES.

By S. A. Neave, M.A., B.Sc., Oxon.

(Plates XXVII–XXXI.)

The following notes on Tabanidae describe specimens collected and life-histories investigated during a recent visit to Southern Nyasaland on behalf of the Imperial Bureau of Entomology.

My headquarters camp was made on the Luchenya River, some three miles from the S.W. corner of Mt. Mlanje. Though expeditions were made, westward to the Shire River and southward and eastward into Portuguese territory, the great bulk of the specimens were collected or bred in the neighbourhood of this mountain.

This is by far the highest mountain in this part of Africa, and, being isolated, it has a somewhat peculiar fauna. The rainfall is exceptionally heavy in its neighbourhood, in most years from 90–100 inches, though the area over which this occurs is defined in a remarkable manner, being limited to the southern and south-eastern slopes of the mountain and to a narrow belt some 3 to 5 miles wide alongside them. The other slopes and sides of the mountain only receive some 35 inches of rain, which is about the normal rainfall for the surrounding country. This peculiar state of affairs is due to the fact that all the rain-clouds come up from the south or south-east, so that the bulk of their moisture is precipitated on those aspects of the mountain. The flora within this rain-belt is characterised especially by the much greater size of the trees and the tendency to produce more or less dense forest, which has, in the past at least, clothed the greater part of these slopes and the foot-hills of the mountain.

Mt. Mlanje is nearly 10,000 feet high, but the main peak rises from a number of rolling plateaus averaging about 6,500 feet above sea-level. These plateaus are largely open country, covered with short grass, the hollows and banks of streams being generally covered with dense forest. The next stage in descent is on the steep main escarpment of the mountain, in many places consisting of sheer precipices, but containing in its hollows a good deal of forest; this descends to an elevation of about 2,400 feet. From this point, which is practically the foot of the mountain, is an area sloping gradually down to 2,000 feet, which on its south and south-eastern sides is heavily timbered for some 3 to 5 miles. Beyond this again is the ordinary woodland and bush country, interspersed with small grassy plains, which is characteristic of this part of Africa.

The first of these localities—viz., the plateau at 6,500 feet—produced but few Tabanidae. A rather dark form of *T. taeniola variatus*, Wlk., which occurred in some numbers in November, was the only representative of the genus *Tabanus* found there. As is the case on all the larger mountains of Eastern Tropical Africa, the genus *Haematopota* was represented by large, heavily-marked species, a large dark form of *H. distincta*, Ric., being very common, and accompanied by a few examples of another, perhaps new species, somewhat resembling it.

The only other Tabanid present was the new *Silvius monticola* described below, which is a small, dusky, rather sluggish insect, and was found just hatching out in large numbers about the middle of December, 1913.

On the slopes of the mountain, especially in the forested areas, between about 3,000 and 4,500 feet, TABANIDAE become much more numerous, though even here members of the genus *Tabanus* are few, *T. insignis*, var. *sharpei*, Aust., being the commoner. *Haematopota* (*Holcoceria*) *nobilis* was fairly numerous, as also were both the mountain species of *Haematopota* above-mentioned, but with their relative abundance reversed, the presumed new species being by far the commoner. The only species of *Chrysops* found in this locality was *C. magnifica*, var. *inornata*, Aust.

The heavily wooded and forested areas around the foot of the mountain were rich in species, if not in individuals, of TABANIDAE, though here again members of the genus *Tabanus* are decidedly scarcer than in the drier country lying further out from the mountain. The most remarkable species obtained, described below as *Silvius apiformis*, but for which a new genus will not improbably require to be erected, has a singular general resemblance to a honey-bee. It frequents only the wooded streams, the vicinity of which it never seems to leave. The other principal Tabanid genera were well represented throughout this area, except *Pangonia* (*sens. lat.*) the only representative of which was *Dorcaloemus fodiens*, Aust. This was probably due to the humid nature of the locality, flies of this genus being much more numerous in drier areas.

In the drier country outside the range of the climatic effects of Mt. Mlanje, TABANIDAE, as elsewhere in the lower-lying parts of Nyasaland, are very numerous, the genus *Tabanus* being dominant both in species and individuals.

Additional experience of the TABANIDAE in this part of Africa has not provided appreciable further data on their habits beyond those already recorded in an earlier volume of this Bulletin (vol. iii, pp. 279–299), and the collection of these flies was again carried out on the same lines as therein described. No great difficulty was met with in obtaining good series of the males of most of the commoner species, except in the case of those inhabiting dense forest, including such species as *Chrysops longicornis*, *C. magnifica* var. *inornata*, *Haematopota* (*Holcoceria*) *nobilis*, etc. The males of these forest-frequenting flies are not easy to secure, owing to the great difficulty in discovering their drinking places (l.c., p. 281).

A considerable number of Tabanids were obtained which were being devoured by predaceous flies of the family ASILIDAE—viz., *Dorcaloemus* 2, *Chrysops* 1, *Silvius* 22, *Haematopota* 37, *Tabanus* 13. As regards these figures it must be remembered that, while ASILIDAE do not become numerous until the rainy season has begun in early December, the season when the majority of species of *Tabanus* are on the wing is considerably before this. Consequently, in proportion to their large numbers, relatively few are represented in the above list, and more than half of these belong to late species, such as *T. sandersoni*, Aust., and *T. fuscipes*, Ric.

In November 1914, examples of a fossorial wasp, *Bembex möbii*, Handl., were captured in the act of carrying off five females of *T. taeniola* and one of *Haematopota*

mactans, which were feeding on cattle. These predaceous Hymenoptera were not very common near Mlanje, the locality not being a sandy one. It is exceedingly difficult to take them with prey, except by watching for them as they hawk the flies on the bodies of stock.

With regard to the breeding habits of TABANIDAE, the study of which was the chief object of my recent expedition, my early efforts to obtain the larvae did not meet with success, but this was mainly due to the work having been begun at the wrong season of the year. My first attempts were made between February and April, 1913, but the experience of the following year showed that their failure was due partly to lack of experience in respect of likely localities, and partly to the fact that in the case of a large number of species the larvae, at this season, were very small and immature, and consequently exceedingly difficult to find.

I had long thought, from previous experience of such localities as the Luangwa valley in Northern Rhodesia, that the sandy river-beds of the lower ground—where individuals of the genus *Tabanus*, at least, are abundant from September onwards—would, if anywhere, be comparatively easy places in which to find the larvae. With this end in view, I spent some five weeks during July and August in the valley of the lower Shire and its tributary, the Mwanza. Here, in the sand and mud on the banks of the rivers, I was successful in obtaining large numbers of larvae, though not of many species. The majority of these, which ultimately proved to be those of *T. biguttatus*, Wied., were found in mud amongst the *Phragmitis* reeds on the banks and in the back-waters, etc., of the Shire River. They often occurred, especially if the mud was inclined to be dry, at a depth of as much as 6 or 8 inches. Plate xxix, fig. 1, is a characteristic scene on the Shire River; in the flat sand-bank to the left of this picture large numbers of the larvae of *T. biguttatus* were found.

The lower part of the Mwanza River was dried up at the time of my visit, except for a few isolated pools, on the banks of which many larvae of *T. biguttatus* were found in the mud. Some other larvae from which I did not succeed in obtaining the adults, but which from other evidence are thought to have been those of *T. pertinens*, Aust., were found usually in the water itself among the roots of floating plants.

The experience gained in obtaining these larvae under comparatively simple conditions proved invaluable when I returned to my headquarters at Mlanje in the middle of August. It was not long before larvae were located there, those of *Chrysops longicornis*, Macq., being amongst the first found, and from then onwards, until my final departure at the end of February, considerable numbers of larvae of many species of *Tabanus*, *Haematopota* and *Chrysops* were obtained, and from these the adults were bred in most cases. Details are given later under the species to which they are referable.

From the results of a whole year's collecting of the adults in one locality and from other evidence obtained from the larvae, it is probable that the majority of Nyasaland Tabanids have only one brood a year. This is certainly true of nearly all the species of *Tabanus* and of *Dorcaloemus fodiens*, Aust., the only fly of the genus *Pangonia* (*sens. lat.*) which was found to occur near Mt. Mlanje. It is possible, however, that certain species of *Chrysops* and *Haematopota* may be double-brooded; much doubtless depends upon the larval food supply, climate, etc.

In the case of many species the larva grows very slowly after hatching and often takes some six months or more to become full-grown. It then, especially in species of *Tabanus*, goes through a resting period, during which it remains buried in mud or sand, sometimes at a considerable depth. In contrast to this lengthy larval stage, the pupal period is short, varying, in my experience, from 10 to 16 or 18 days, according to the species and the climatic conditions, the longer period being usual for the larger species of *Tabanus*.

One difficulty connected with the question of these flies having more than one brood per annum arises from the fact that even in larvae from the same batch of eggs the rate of growth is extremely variable, and consequently the processes of pupation and emergence do not take place simultaneously in a certain proportion of the individuals. Some of the remainder take longer to reach maturity, others seem to pass through an extended dormant period. The adults arising from these emerge at irregular intervals, often months later. This probably explains the capture of odd specimens of any species long after the usual season. It would also seem not improbable that individuals which miss their normal season for pupation in some circumstances continue in the larval stage until the following year. Thus I possessed in my laboratory in January and February examples of larvae of *T. corax*, some still in a dormant state and others not yet mature, the season for the adult flies being over by the beginning of January. It would appear that these would not have produced imagines until the following December, though I was unable to decide this point on account of my return to England.

The problem of rearing in captivity and, still more, the segregation of a large number of unidentified species of Tabanid larvae was no easy one. The larvae, especially of the larger species, are astonishingly strong and active, and in spite of their semi-aquatic habits, can travel considerable distances over a perfectly dry surface without apparent inconvenience. They are also very liable to wander, chiefly at night, and it is probable that in nature they come to the surface a good deal at this time to search for food. They were therefore singularly difficult to control and retain in their respective receptacles, and on numerous occasions numbers of larvae of the smaller species were destroyed by vagrant individuals of some large species such as *T. corax*. On the whole the best receptacles, from the limited choice which was obtainable locally, consisted of small basin-shaped vessels made of hard clay by the local natives. These were of various sizes, from 6 inches to a foot in diameter. They were placed separately under cages made of mosquito netting on a wooden framework. The larvae were recovered for examination or other purposes by merely washing them out of the mud or sand in which they were placed. This, of course, required to be done very carefully in the case of the smaller species. Pupae found under these circumstances should be separated from the larvae, which might injure them. They should be placed vertically and head upwards just below the surface of the mud or sand in separate basins. The soil in which the pupae are kept, should be considerably drier than that which best suits the larvae.

The majority of the larvae obtained were already half-grown when captured and the necessity of providing them with very minute forms of food did not arise. The best food for the smaller species appeared to be the immature larvae of

various Muscid flies, collected from the carcases of rats, etc., trapped for the purpose. These larvae buried themselves at once in the mud, where they were apparently consumed by the Tabanid larvae, which thrived under these conditions. The larger species also greedily attacked the freshly-killed bodies of small tadpoles, molluscs and fish-fry placed on the surface of the mud, though they were seldom actually seen to do this, unless examined at night. It was found in most cases that the Tabanid larvae did best in mud or sand (this point being usually decided by the conditions under which they had been found) which was very wet, but without standing water on the surface. Before the larvae have reached their full growth, which in many cases signifies the beginning of a resting period, they usually lie buried in the mud, head downwards, with their syphons projecting immediately above the surface of the mud or of a shallow layer of water above it, if it be present. In the resting stage the syphons do not seem to be made use of and the larvae remain several inches below the surface for weeks or even months. This is presumably an adaptation connected with a climate in which there is a very marked dry season, and consequently, a risk of the mud in which they are lying, more or less drying up.

If it is necessary to transport for any distance larvae which have not reached the resting stage, it is important that the jars, etc., in which they are placed should only contain wet mud or sand and that there should be no standing water on the surface. Some of my earliest captures, which had to be transported some 50 or 60 miles from the Shire River to Mlanje, were nearly all lost from this cause, the larvae being apparently drowned by the movements of the water on the surface.

Pupation appears to take place in normal circumstances an inch or more below the surface, though occasionally in captivity, individuals pupated lying horizontally upon it. The pupa is normally upright in the mud and after pupation, as soon as the case has hardened, it works its way up by means of its rings of spines and the aster (a name proposed for the terminal whorl of spines), until the pupal head lies just below the surface, being often visible from above. The pupa at first is usually of a pale yellowish or greenish colour, but darkens as the imago develops within, the process beginning with the eyes.

In normally fine weather the imagines of all species almost invariably emerged between noon and 3 p.m. They were more irregular during spells of dull and rainy weather. The process of emergence seems to be quite similar in individuals of all genera, whether *Chrysops*, *Haematopota* or *Tabanus*. The head of the pupa splits in the median dorsal line and the imago rapidly emerges until only the end of the abdomen, which is at first enormously elongated, remains in the pupa-case. The wings at this stage are milky white and the darker markings, if any, are barely visible. The imago usually remains in this position for some two or three minutes before completely leaving the pupa-case. It is capable of flight very soon after this, but if undisturbed sits for about half an hour on any suitable object near by while the wings dry and assume their normal coloration and the abdomen its normal shape. During this period several drops of a milky white fluid are passed per anum. Flight, however, seems invariably to take place before the wings are

completely hard and dry, and indeed, I am inclined to think that a short flight, at least, is necessary to bring this about. One result of this, is the unexpected fact that it is really more difficult to obtain perfect specimens of TABANIDAE from bred individuals than from collected ones. I found that the best method was to transfer the flies, as soon as they exhibited a desire to attempt to fly, to clean, dry, glass tubes in which there was only just room for them. These were only closed with mosquito netting, not corked, otherwise the moisture from the newly-emerged flies collected on the walls of the tube and entangled their wings.

A variety of experiments were made in an endeavour to keep various TABANIDAE alive in captivity. They did not meet with very great success, and it was very soon found that the flies died at once in any cage, large enough for them to fly in, *which was made of hard or resistant materials*. This was especially the case with examples of the genus *Chrysops*, which seldom, if ever, survived a single day. Species of *Haematopota*, being more sluggish insects, did not knock themselves about to the same extent and lived longer, some nearly a fortnight. They were difficult to feed, except on the human arm placed against the cage, and appeared to take no notice of a living rat introduced into the cage. The most successful experiment with living TABANIDAE was conducted with a comparatively large cage made of mosquito-netting and wood, each partition measuring about 5 feet by 4 feet by 3 feet, in which were boxes containing grasses and growing plants. The mosquito-netting was loosely attached to the cage, so that the shock to a fly in striking against it was minimised. In this type of enclosure both sexes of some of the larger species of *Tabanus*, e.g., *T. biguttatus* and *T. corax*, were kept alive for more than three weeks. They fed greedily on honey and water poured on to a dish full of sand and seemed to benefit by the position of the cages being so arranged that sunshine reached a portion of them during the course of the day. They could not be induced to suck blood in these cages, and did not oviposit, but, judging by the recent interesting work of Mitzmain,* if it had been possible to build cages sufficiently large to enclose a good-sized mammal, I have little doubt that both these and other species could have been kept alive longer and induced to breed.

One or two captured females of *T. corax* oviposited in these cages, the process in one instance taking nearly an hour, between 3 and 4 p.m. Many egg-masses of this species were also obtained in the bush, always on reeds or grasses overhanging mud. While the female is ovipositing she is not easily disturbed, as King has already noticed in the case of *T. biguttatus*,† and on one occasion a collector brought me the reed, fly and all, from more than a mile distant without disturbing her. The egg-mass with its cement covering is pure white when first laid, becoming dark grey as it hardens.

The cement which covers these egg-masses must be of a remarkably waterproof and insoluble character, as some individuals from them succeeded in hatching even though the egg-mass had been for two days in 70 per cent. alcohol.

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* Philippine Journal of Science, Sect. B. vol. viii, 1913, pp. 197–221.

† Third Report of the Wellcome Research Laboratories, 1909, pp. 213, 214.

The egg-masses of *T. corax* are of the usual Tabanid type, all the individual spindle-shaped eggs being laid with their long axes in the same direction. In the cases observed, hatching took place about the fifth day, but this would be likely to be lengthened or shortened in some cases, according to the temperature. The process of hatching is a remarkable one and takes place with surprising suddenness. The egg-mass splits in the middle line, following the long axis, and the small larvae emerge almost simultaneously, forming a large quasi-viscous drop which falls bodily from the reeds, etc., into the water or mud below.

The young larvae, in my experience, grow very slowly at first and differ from the later stages in being more active and swimming more freely in water (which they do by lashing themselves along the surface). The more mature larvae, especially of the larger species, appeared to be principally nocturnal in their habits. Most species are, I think, more or less cannibalistic, but this seems to be largely a question of the age of the larvae, and the species in which this habit is most marked seem to lose it as they become mature. The large larvae, especially those of a species like *Tabanus corax*, are very savage when disturbed and strike at everything within reach with their mandibular hooks, which readily penetrate the skin of the hand.

With regard to questions of the morphological details of the numerous larvae and pupae obtained, I have been much indebted to Mr. James Waterston, of the Imperial Bureau, who has given me much assistance on these points and has suggested the convenient name "aster" for the group of hooks at the termination of the last segment of the pupa. The form of this differs a good deal in the various species, and another character which seems of some specific value is the nature of the uppermost section, often isolated, of the series of combs on the anterior part of the last segment; this I have called the dorso-lateral comb. It is not always present and varies much in form.

Specific differences amongst the larvae are, except in certain species, not so easy to detect, especially in those of *Haematopota*. They are generally to be found in the distribution of the pigmented areas on the last segment around the base of the syphon and the anus. These so-called pigmented areas are really, as Mr. Waterston has pointed out to me, areas of pigmented hairs, in which are entangled small foreign bodies. Their actual colour therefore varies to some extent with that of the medium in which the larvae have lived. The amount of pigmentation, though not its distribution, also varies with the age of the larva.

Owing to the absence of Mr. E. E. Austen on active service, I have been compelled myself to describe the more striking of the new species in the collection and have utilised the beautiful drawings of Mr. Terzi, which had been intended for a separate paper by him, to accompany my notes on the insects themselves and their life-histories. I also received most valuable assistance in Nyasaland from Mr. E. Ballard, then Government Entomologist in that Protectorate, who was kind enough to make a number of drawings from life of the various larvae then being discovered, which were subsequently invaluable in the difficult work of identifying and sorting them.

Thriambeutes sp.

A single male of an unidentified species of this genus was captured on the Kola River, a little east of Mt. Chiperone, Portuguese East Africa, in November 1913. It was found on the leaves of a shrub near water. The upper, large facets of the eyes are of a greenish gold colour in life, the lower small facets being dusky.

Pangonia oldii, Aust.

Both sexes were captured in some numbers in July on the Mwanza River, Upper Shire, where the conditions were distinctly dry. Individuals were somewhat inclined to enter tents and the females occasionally attacked the bare skins of natives.

Dorcaloemus fodiens, Aust.

A large series of both sexes (the male was formerly described as a distinct species, *D. bicolor*, Aust.) was taken in April not far from Mt. Mlanje, both in British and Portuguese territory. The males were in the majority, and between the 1st April and the 2nd May, the only period in the year during which they were on the wing, 74 males and 28 females were captured.

Two or three attempts were made to keep these flies in captivity, and they were provided with damp earth, flowers, honey, etc. They could not, however, be induced to feed or oviposit and death took place in from two to four days. Life was prolonged if their cages were placed in the sun for part of each day.

Some examples of what may be the larvae of this species were found, though the point could not be decided, as I was obliged to leave before they reached maturity. They were captured during December, January and February in some swampy ground on which a patch of maize was growing. These larvae were of fair size, some 30 mm. in length; the syphon was very short and had a distinct pigmented ring on the anal segment resembling that in *Haematopota* larvae. In the more mature specimens traces of intersegmental pigment were present.

At the time these larvae were captured no other larvae of so large a species were obtainable, and as *D. fodiens* is the only large Tabanid which is on the wing in the neighbourhood in March and April, there are some grounds for thinking that the larvae belonged to that species.

Silvius apiformis, sp. nov.

This very remarkable species, which is only provisionally placed in this genus, bears a striking resemblance to a large hive-bee of the golden type usual in Central Africa.

♂. Length (one individual), 14 mm.; length of wing, 12 mm.

♀. Length (twelve individuals), average, 13·5 mm.; length of wing, average, 11·1 mm.

♂♀. *Head* with a very broad front in the ♀ (fig. 1), the eyes being widely separated, covered with long hairs, dusky around the ocellar triangle and fading to a pale buff toward the base of the antennae; the whole of the *peristome* also covered with long hairs of a pale buff colour. *Palpi* fawn. *Antennae* (fig. 2, *a*) short and stout,

the first and second joints, which are covered with long hairs, being buff-coloured, the third joint dusky. *Eyes* of both sexes dusky, the ♂ head holoptic and the eyes not divided into areas with large and small facets. *Thorax* dusky, sparsely covered

Fig. 1.
Silvius apiformis, sp. n.; side view of head of ♀.

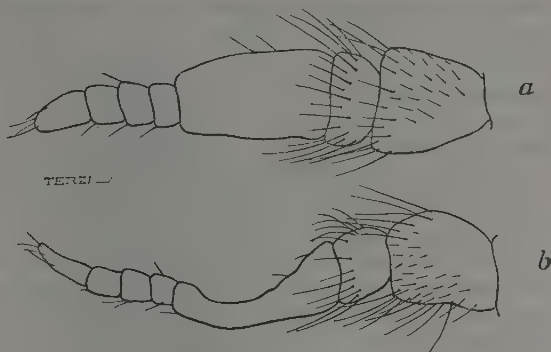


Fig. 2.
Antenna of (*a*) *Silvius apiformis*, sp. n.: (*b*) *Silvius montico a*, sp. n.

with pale buff hairs. *Abdomen* bright fulvous yellow, banded with black as shown in fig. 1, the median spot on the second segment varying a good deal in size in different individuals and especially large in the ♂. *Wings* hyaline, with a strongly

Fig. 3. *Silvius apiformis*, sp. n., ♀. × 4.

marked sepia-coloured patch at the base extending to the humeral cross-vein and to the base of the basal cells; the somewhat darkened area around the discal cell not so evident to the naked eye as it is indicated in the figure. *Halteres* dusky. *Legs* dusky, except for proximal two-thirds of tibiae, which are whitish, the femora in some individuals having a somewhat rufous tint.

NYASALAND: *Type* ♂, Mlanje, 28 x. 13; *type* ♀, Ruo R., near Mlanje, 25 x. 13; and 133 other ♀♀ from the same localities.

This striking species was taken in some numbers between the 13th of October and the end of that month. From that time, though occasional specimens were taken up to the middle of November, it became very scarce. It has evidently therefore a very short season, and this, coupled with its singular habits and apparently limited distribution, probably explains why it has not been discovered before. I found it only in the Luchenya and Ruo (see Pl. xxix, fig. 2), two forested rivers, which rise on Mt. Mlanje. It did not, however, occur on the mountain side, only in the more forested portions of the rivers where they had debouched into comparatively flat country. This fly was never seen except in the immediate vicinity of these rivers, in fact, only over the surface of the water or on the actual bank. It has a very swift and powerful flight, and was only captured in any numbers by stationing collectors in the river to watch projecting rocks, tree-trunks, etc., in the bed of the stream or at the water's edge, points where it had a habit of settling at intervals for a second or two. It makes a very deep note on the wing, which my native collectors learnt to recognise at a distance. It is not very clear what animals this insect feeds on. I have no record of its biting man. There are no crocodiles in these rivers, at least on the part of them in question, though *Varanus* lizards are common and there are a few hippopotami in the Ruo.

Silvius monticola, sp. nov.

A rather small dusky species somewhat resembling in appearance *S. australis*, Ric., from North Queensland, Australia.

♂.—Length (10 individuals), 8·4 mm.; length of wing, 7·9 mm.

♀.—Length (10 individuals), 10·4 mm.; length of wing, 10·3 mm.

♀.—*Head* with the front narrow, pale buff at edges, dusky in centre; ocelli and the narrow, vertically elongate callus, black; *palpi* short and covered with black hairs; *antennae* (fig. 2, *b*) black, the first two joints being clothed with black hair, and the proximal portion of the 3rd joint curiously curved (fig. 3 *b*). *Thorax* dusky, with two evanescent pale buff lines, of which little remains in most individuals but two triangular patches on anterior margin; external to these triangles are humeral spots of the same colour. *Abdomen* black, the posterior margin of each segment being edged with pale buff (fig. 4). *Wings* hyaline, somewhat infuscated at base and along costa. *Legs* black.

♂.—Smaller than the ♀, the hair on the peristome, thorax, etc., being buff instead of black; thorax more hairy and the two pale thoracic stripes more defined. On the abdomen the pale margins to the segments broader, especially at the sides of the anterior ones; the tibial joint of all pairs of legs fulvous, not dusky.

The ♂ head is holoptic and there is no division in the eyes into large and small facets; the eyes are dusky, with a green or bluish-green sheen; the ♀ eye also dusky, with a slight purplish iridescence, occasionally greenish like that of the ♂, but not so bright.

NYASALAND: Mlanje Plateau, 6,500 ft., 18 and 19.xii.1913 (*types* ♂ and ♀); also about 160 ♂♂ and over 100 ♀♀ taken at the same time and place.

Fig. 4. *Silvius monticola*, sp. n., ♀. × 5.

I was fortunate enough to have paid a hurried visit to Mlanje Plateau at the moment when this remarkable species was emerging in large numbers. Both sexes were found in abundance in the short grass on the more open parts of the Plateau. Many individuals were taken *in copula* and numerous others as the prey of ASILIDAE. Perhaps because they had recently emerged, these flies, especially the females, were remarkably sluggish. Though occurring in great numbers during its season, it probably is on the wing for only a very short time.

Genus CHRYSOPS.

This genus was unusually well represented in the region of Mt. Mlanje, though with the exception of *C. magnifica* var. *inornata*, which was not uncommon on the wooded slopes, it was not represented on the mountain itself. Of seven species collected, no less than three prove to be new to science.

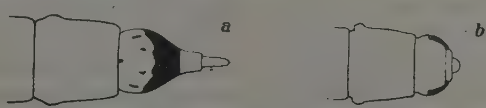


Fig. 5. Terminal segments, seen from above, of the larvae of, (*a*) *Chrysops*, (*b*) *Haematopota* (diagrammatic).

The larvae or pupae of four species were obtained and the adults bred from them. The larvae, in which, in some cases, it is not easy to recognise specific differences, are roughly of the same size as those of *Haematopota*, but of somewhat different shape, tapering toward the anal segment and with a long syphon. In the larvae of *Haema-*

topota the anal segment is not less broad than the preceding ones and the syphon has the appearance of having been cut off short. The arrangement of the pigmented areas, as may be seen from the drawings (fig. 5), is characteristically different in the two genera.

From the figures of the larvae of *Chrysops wellmani*, Aust., and *Haematopota crudelis*, Aust. (Plate xxvii, figs. 3 and 6), it will also be seen that the thoracic segments are more tapering in the former, which are also less opaque than those of *Haematopota*. In the pupa, the antenna is placed much more anteriorly in *Chrysops* than in *Haematopota* and the dorso-lateral comb is absent in all those species of *Chrysops* I have seen, though apparently usually present in the pupa of *Haematopota*.

Chrysops longicornis, Macq.

This species is by far the most abundant of the genus in the neighbourhood of Mt. Mlanje. Males were, however, seldom captured. It was not until larvae were found and the imagines bred, that appreciable numbers of males were obtained. These flies prefer well-wooded localities and resemble *C. funebris*, Aust.,* in their habits. They are on the wing in the Mlanje district throughout the long wet season. It is, however, doubtful whether there is more than one generation per annum, as the long period over which the adults are on the wing may be explained by the irregularity of emergence, and by the probability that in a forest-haunting species, such as this, all stages are in existence nearly throughout the year.

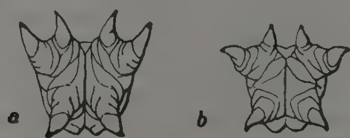


Fig. 6. Pupal aster of *Chrysops longicornis*, Macq.; (*a*) ♂, (*b*) ♀. × 35.

The larvae of this species were first discovered at the end of August 1913, and much to my surprise, in view of the habits of the adult, were found in the mud in a small marsh and stream bed in an open spot with nothing but comparatively thin woodland near it (see Plate xxx, fig. 1). Many other examples were subsequently taken, both in similar places, and in less unexpected spots on the banks of wooded streams, etc. Except for an occasional freshly emerged individual, the adult flies were not taken in these open places and appear therefore to migrate from them after emergence and to return to them for the purpose of oviposition. If this is the case, it is another example of the possibilities of error in searching for the breeding place of a species in the spot most frequented by the adults.

The larvae (Plate xxvii, fig. 2) of this species were obtained in considerable numbers from September onwards, a few being still obtainable even in January and February.

* Bull. Ent. Res. iii., p. 285.

Chrysops magnifica, var. **inornata,** Aust.

This species is by no means an uncommon one in the Mlanje district. It is on the wing during the rains from October to April. Males are scarce in the field, though a few were obtained. On the 23rd December and again on the 20th January, 1914, a pair was taken *in coitu* on rocks in the bed of a mountain stream. The remarkable point about the males of this variety is that they have clearly developed the two longitudinal black abdominal stripes of typical *C. magnifica*, Aust., from German East Africa, of which, however, the male is as yet unknown. In the eyes of the male the large facets are iridescent golden-green, without spots or marks, the small facets being deep ultramarine blue, with zigzags of golden-green, as in the eye of the female.

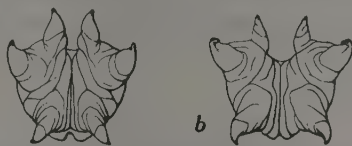


Fig. 7. Pupal aster of *Chrysops magnifica* var. *inornata*, Aust. (*a*) ♂, (*b*) ♀. × 35.

A few examples, 7 ♂♂ and 10 ♀♀, of this species were bred during October and November. The larva so closely resembles that of *C. longicornis*, Macq., that I never succeeded in satisfactorily separating it, since in both species the usually distinctive characters of the pigmented anal segment and syphon were very variable. The pupal aster resembles that of *C. longicornis*, but the middle pair of hooks is stouter and somewhat more curved, and the shape differs somewhat, especially in the male.

Chrysops fuscipennis, Ric.

This is a rare species in the Mlanje district, a few specimens only being seen in January and February, near my headquarters and also to the north, near the south-west shore of Lake Chilwa. This seems to be about the same time that it is usually taken elsewhere in Nyasaland, and it would therefore appear to be a decidedly late species, as the great majority, if not all, of the other species of *Chrysops* in this part of Africa are on the wing before the rains begin.

Chrysops wellmani, Aust.

This species occurs in fair numbers near Mt. Mlanje from September to January, and a small series of both sexes was obtained. The hitherto unknown male closely resembles that of *C. cana*, Aust. (Bull. Ent. Res., ii, p. 166) from which it differs in

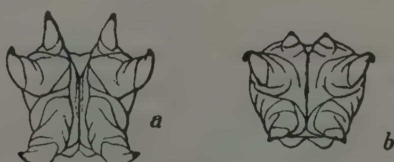


Fig. 8. Pupal aster of *Chrysops wellmani*, Aust.; (*a*) ♂, (*b*) ♀. × 35.

some particulars, especially in the pattern of the eyes. In *C. wellmani* the eyes are somewhat flatter and more compressed antero-posteriorly than in *C. cana* and are of a black colour, the lower half enclosing six irregular spots of a pale iridescent blue.

The larvae of this species (Plate xxvii, fig. 3) differ strikingly from any of the other *Chrysops* larvae that I have seen in their strong pigmentation. They were obtained in the beds of forested streams with those of *C. longicornis* and *C. magnifica* var. *inornata*, but were much less common. They were found only between the middle of October and the end of November.

There is a considerable difference in the hooks of the aster in the two sexes of this species, the upper and lower hooks, especially the former, being much reduced in the female.

Chrysops bimaculosa, sp. nov.

This species is allied to *C. centurionis*, Aust.,* but is much more stoutly built, with shorter wings and of a duller coloration. It is distinguished from other African species of this genus, *inter alia*, by the well-marked transverse black band on the first abdominal segment.

Fig. 9. *Chrysops bimaculosa*, sp. n., ♀. × 6.

♂.—Length (two individuals), 10–10·5 mm.; length of wing, 9–9·5 mm.
♀.—Length (three individuals), 9–9·5 mm.; length of wing, 9–9·5 mm.

Head and front, dull golden, the frontal callus being somewhat darker, as also are the two elongate facial tubercles; first joint of antenna not swollen, dark rufous, second joint black, and third joint dark rufous with a black base. *Thorax* dull brown with a faint median longitudinal dark stripe and two admedian pale yellow stripes, the lateral margins being bordered with yellow hairs; scutellum yellow.

* Bull. Ent. Res. ii., p. 164.

Abdomen with the two anterior segments pale yellow, marked with black as shown in fig. 9; the remaining segments rufous brown; the anterior pair of black spots are elongated transversely and meet in the middle line to form a band; the posterior pair of spots on the second segment are somewhat elongate longitudinally. *Wing* with the costal cells yellowish brown, the remainder dusky, except for the two basal and the anal cells which are hyaline, and the axillary cell which is only lightly dusted with dark scales (the type, having been bred, has the pigmentation of the wing somewhat paler than is the case in a collected example); the halteres dark brown. *Legs* reddish brown.

There is no marked difference between the sexes in this species; the eyes of the male, as in others of this group, are very large, the upper facets being of a golden-yellow colour, with two somewhat curved, horizontal black streaks.

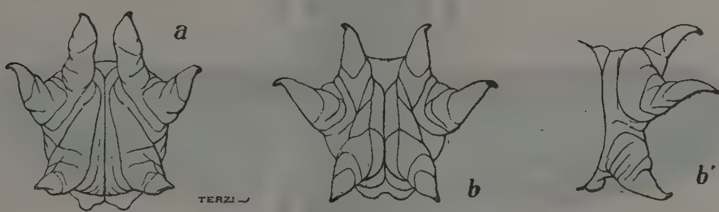


Fig. 10. Pupal aster of *Chrysops bimaculosa*, sp. n.; (*a*) ♂, (*b*) ♀, (*b′*) ♀ side-view. × 35.

NYASALAND: Mt. Mlanje, *types* ♂ and ♀ and one other of each sex bred October and November 1913; one ♀ collected in November 1912.

Of the four above-mentioned bred individuals three were bred from collected pupae and the fourth from a larva, which much resembled that of *Chrysops longicornis*, though considerably larger, with a somewhat less strongly pigmented anal segment and with well-marked hairs on the syphon.

The hooks of the pupal aster, especially the upper and middle pairs, are decidedly elongate.

This is evidently a rare species, and the above were the only specimens met with, the one imago, as well as the larvae and pupae, having been taken on the banks of a forested stream.

Chrysops woodi, sp. nov.

This species, together with the following one, seem to form a distinct group among the African representatives of this genus. They are characterised by their brilliant orange or yellow coloration, the peculiar arrangement of the wing-markings and the very marked expansion of the first joint of the antenna.

♂.—Length (one specimen), 10·5 mm.; length of wing, 8·5 mm.

♀.—Length (two specimens), 10·5–11 mm.; length of wing, 9·5 mm.

Head orange-rufous; ocellar triangle black; frontal callus large, prominent and shining, orange-rufous; a median orange-rufous facial tubercle; smaller laterally-

placed facial tubercles black; the rest of the face, peristome, palpi, etc., orange-rufous; *antennae* black, except for the proximal third of the first joint which is brown; this joint (fig. 12, *a*) is enormously swollen and shortened. *Thorax* orange-rufous, with three distinct black stripes, the middle one being the broadest; another narrower dark line on the pleurae; *scutellum* orange-brown. *Abdomen*

Fig. 11. *Chrysops woodi*, sp. n., ♀. × 5.

orange-rufous, somewhat darker at extremity, with an interrupted, somewhat evanescent, black stripe in the middle line. *Wings* dusky, surrounding an orange-yellow area, as shown in the figure, the axillary cell being more lightly infuscated and enclosing a hyaline area; halteres orange. *Legs* orange-rufous, all the joints outlined in black; the distal joints of the tarsus of the middle and hind legs dusky in the fore legs the whole tarsus and the distal third of the tibia dusky.

The ♂ differs in its somewhat smaller size and in having the whole of the first joint of the antennae yellowish and not black. The eyes are old golden above, below golden green with two deep blue oval spots. The eyes of the ♀ have a golden green ground, with four large, somewhat confluent spots of a deep blue colour, so arranged that the ground colour remains in the form of a rough Maltese cross.

Portuguese East Africa: *Types* ♂ and ♀ from the foothills north of Mt. Chiperone, 2,400 ft., 19. xi. 1913.

N.W. Rhodesia: 1 ♀, paratype, Chilanga, 4,000 ft., 1. xii. 1913 (*R. C. Wood*), labelled "Biting native by stream."

The pair mentioned of this striking and handsome species of *Chrysops*, which I have much pleasure in abdicating to Mr. Wood, were taken about the middle of the day on the leaves of a shrub overhanging a small pool in a more or

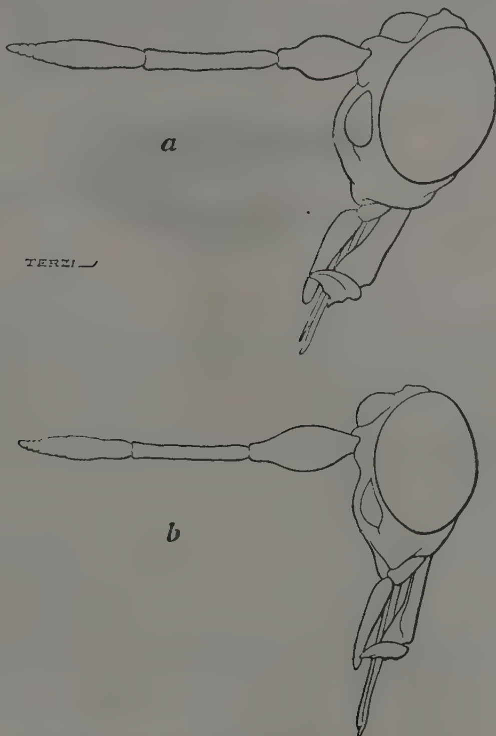


Fig. 12. Side-view of the head of, (*a*) *C. woodi*, sp. n., ♀; (*b*) *C. austeni*, sp. n., ♀.

less dried-up stream-bed. Prolonged search, both then and on my return journey a few days later, failed to reveal any other specimens, so that it would appear to be a rare species, at any rate at that season.

Chrysops austeni, sp. nov.

This species is nearly allied to the foregoing, though clearly distinct from it, being smaller, of less robust build and less brilliant coloration.

♂.—Length (two individuals), 8–9·5 mm.; length of wing, 7–8 mm.

♀.—Length (twelve individuals), average, 10·1 mm.; length of wing, 8·8 mm.

Head and front golden yellow, ocellar triangle black; frontal callus dusky, not quite so large as in *C. woodi*, but even more prominent and slightly nearer the base of the antennae (fig. 12, *b*); median facial tubercle fulvous, the lateral facial tubercles black; rest of face and peristome yellow-brown; palpi rufous; *antennae* with the first longer and slightly less swollen than in *C. woodi* (fig. 12), yellow-brown, with a varying

amount of dusky at the distal end; second and third joints dusky, the former having a trace of fulvous at its proximal end. *Thorax* golden yellow, with a narrow median and a pair of broader, black lateral stripes. *Abdomen* orange-fulvous, somewhat darker at extremity, with a black median stripe, much better marked than in *C. woodi*, being only slightly interrupted at the edges of the segments. The pigmentation of the *wing* (fig. 13) resembles that of *C. woodi*, but the inner pale

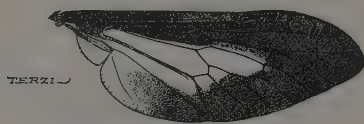


Fig. 13. Wing of *Chrysops austeni*, sp. n. × 5.

area is whitish and translucent, somewhat fulvous on its edges, and does not extend towards the costa from the discal cell as it does in that species (fig. 13). *Legs* as described for *C. woodi*, but only the tip of the tibia in the fore leg is dusky, the joints of the other legs being less clearly outlined with a dusky band, which is missing altogether at the distal end of the middle tibia.

The ♂ differs in its somewhat smaller size, the whole of the first joint of the antenna a and the proximal part of the second joint being fulvous. The eyes are dull golden above and below pale golden green with two dark blue spots. The eyes of the ♀ are pale shining green with four dark blue spots, the upper pair being more elongate than the lower.

NYASALAND: *Types* ♂ and ♀ and one other ♂ and 86 ♀♀ from the plains to the S.W. of Lake Shirwa (or Chilwa), 11–15, i, 1914.

This fine species was abundant in open, rather short grass country in the middle of the rains. I have great pleasure in dedicating it to Mr. E. E. Austen, who would have himself described it, had he not gone on active service.

Genus HAEMATOPOTA.

This genus was well represented in the neighbourhood of Mt. Mlanje, and several species were collected which are probably new to science, but are not included in this paper. The larvae were by no means easy to obtain as compared with those of *Chrysops*, a few individuals of three species only being found in September and October. Later in the season, in January, considerable numbers of the larvae of an unidentified species were obtained, perhaps those of *H. insatiabilis* or an allied species. The larvae all seem to resemble each other closely and it is very difficult to distinguish specific differences in them, though they differ in a marked manner from those of any other genus of TABANIDAE which I have seen. The differences between these larvae and those of *Chrysops* have already been discussed under that genus. The limitation of the pigmented areas to the anal segment and the abruptly truncated syphon seem to be characteristic of and peculiar to this genus, as also are the very short, sometimes almost invisible, pseudopodia.

Haematopota pertinens, Aust.

This species does not occur quite near Mt. Mlanje, the country being too heavily forested. It is not uncommon in the more open country towards the Ruo River, and in January 1914, I found it abundant to the south-west of Lake Chilwa (or Shirwa), where I took a few of the hitherto unknown males.

Haematopota furtiva, Aust.

Nine females of this species were captured near the south-western shores of Lake Chilwa in the middle of January 1914.

Haematopota nociva, Aust.

A few individuals of this species were taken at Mlanje at the end of December and the beginning of January.

Haematopota abyssinica, Surc.

A few examples of this species were taken near Mt. Mlanje in November and December, but it was not common.

Haematopota ingluviosa, Aust.

This recently described species was found in some considerable numbers near Mt. Mlanje and a good series, including many examples of the hitherto unknown male, was obtained.

Haematopota insatiabilis, Aust.

An abundant species near Mt. Mlanje about November and early December, being replaced in that month and during January by another, apparently new, species, which somewhat resembles it. A few larvae of *H. insatiabilis* were obtained, and from some of these three females were bred between the 7th and 10th of November 1913.

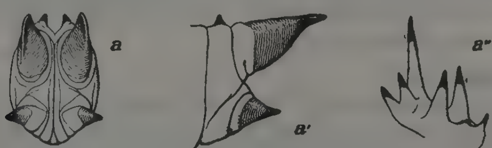


Fig. 14. Pupal aster of *Haematopota insatiabilis*, Aust., ♀; (*a*) from behind; (*a'*) side view, × 35; (*a''*) dorso-lateral comb, × 70.

What is believed to be the larva of this species is figured on Plate xxvii, fig. 5. The pupal aster of this species is very remarkable, the upper hooks being reduced to mere knobs, while the middle pair are enormously enlarged. A well-marked dorso-lateral comb is present. For the whole pupa see Plate xxvii, fig. 4.

Haematopota mactans, Aust.

Though widely distributed and occurring throughout the wet season, this was never a very abundant species, especially at Mlanje. It was less uncommon over the Portuguese border to the south.

Haematopota crudelis, Aust.

Although the original specimens of this recently described species came from German East Africa, it proved to be by no means uncommon near Mt. Mlanje, and in the months of October and November considerable numbers of both sexes were taken. The first larvae of this genus which I succeeded in obtaining belonged to this species. Several of the larvae were found in September and October, and though

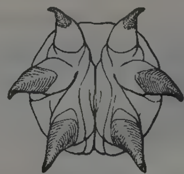


Fig. 15. Pupal aster of *Haematopota crudelis*, Aust. × 35.

many were lost, 2 males and 3 females eventually emerged in October and November. The larva (Plate xxvii, fig. 6) differs from that of *H. insatiabilis* only in the pigmented areas round the anus and at the base of the syphon being more pronounced. The pupal aster has hooks of nearly equal length and forms a very regular star. There is no true dorso-lateral comb, though one female individual has a minute knob-like process in place of it.

Haematopota distincta, Ric.

What appears to be a large black form of this variable species, closely resembling the melanic form of *H. alluaudi*, Surc., was common on the Plateau of Mlanje Mountain. It also occurred, but less commonly, in the forests on the slopes of the mountain, where it was largely replaced by another species apparently allied to it and to *H. neavei*, Aust. This species and its allies are all essentially forest insects and are usually associated with mountains, being generally present in very large numbers when they do occur. I was not successful in finding the larvae, which it is to be supposed live in running water or possibly in the soil in the dense forests, which is always more or less wet in these localities.

Haematopota decora, Walk.

This was not a common species in the Mlanje district, as it prefers lower and drier country, but a few individuals were taken and a single female was bred from a collected pupa on the 26th November 1913. The larva was of the usual *Haematopota* type, but the pigmented areas on the anal segment were of an orange colour. This might,

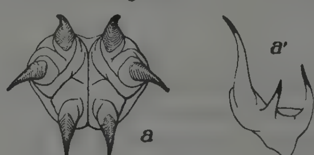


Fig. 16. *Haematopota decora*, Walk., ♀; (*a*) pupal aster, × 35: (*a′*) dorso-lateral comb, × 70.

however, have been due to the mature condition of the larva, which was about to pupate. The pupal aster is regular in shape. A dorso-lateral comb, consisting of three spines, is present.

Haematopota vittata, Lw.

A widely-spread, but not very abundant species, which is on the wing throughout the rainy season.

Haematopota (Holcoceria) nobilis, Grünb.

Although I had long felt sure that this species must occur at Mlanje, it was not until October 1913 that I actually discovered it there. It does not occur among the forests on the lower ground at the foot of the mountain, but apparently only on the forested slopes, where it was not uncommon from the end of October until toward the end of December. Efforts to find the larvae or pupae in or near the mountain streams, where it most probably breeds, were unsuccessful. Probably a search should have been made for them somewhat earlier—viz., in August or September.

Genus Tabanus.

As already explained, the representatives of this genus are most dominant in the lower and drier parts of the country, where vast numbers of individuals occur in the season, chiefly from October to January. Near Mt. Mlanje, though individuals are not particularly abundant, the number of species is nevertheless large. The larvae of many species of *Tabanus* were found, and some of them in considerable abundance. In some cases, such as in the highly pigmented species of which *T. insignis* may be taken as a type, recognition is very easy. In others, such as those of *T. biguttatus*, *T. maculatissimus* and *T. taeniola*, there is a considerable general resemblance, and though the adult larvae are fairly distinct, the immature forms are more difficult to separate. The end of the anal segment forming the base of the syphon is generally long and tapered, and not somewhat bottle-shaped as in *Chrysops*, nor short and abruptly terminated as in *Haematopota*. A dorso-lateral comb is usually present in the pupa and is sometimes very strongly developed.

Tabanus africanus, Gray.

This is primarily a low-country, lake-shore and river-valley species, and was scarce at Mt. Mlanje itself, though common to the north and east, especially near Lake Chilwa. It is on the wing from October or November until the end of May in some localities, and may therefore be a two-brooded species, even in Nyasaland. I did not, however, obtain the larvae, so can throw no light on this point.

Tabanus maculatissimus, Macq.

A common species in the neighbourhood of Mt. Mlanje, though, as on former occasions, the males were exceedingly hard to find. A few individuals, two males and five females, were bred during November from larvae obtained in Portuguese territory to the east of the mountain. They were found in mud in a partially dried-up stream. These larvae were not, however, at the time distinguished from those of *T. biguttatus*, of which they were thought to be immature examples. The figure (Pl. xxvii, fig. 7) is from other individuals, obtained subsequently, which

are believed to belong to this species. The pupal aster is normal except for a papilla on each side of the middle line, about the middle. There is a well-marked dorso-lateral comb, consisting of comparatively short, stout spines.

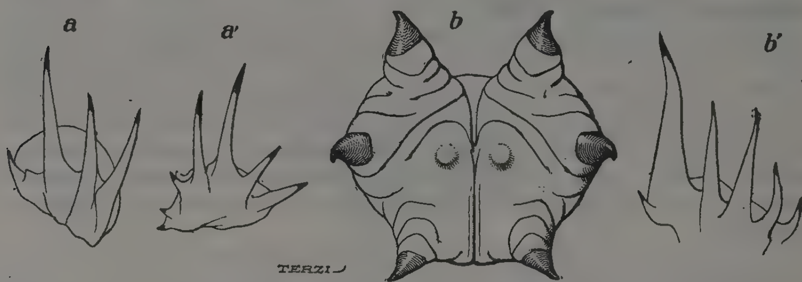


Fig. 17. *Tabanus maculatissimus*, Macq.; (*a*) dorso-lateral comb of ♂, × 70; (*a'*) do. of another individual; (*b*) pupal aster of ♀, × 35; (*b'*) dorso-lateral comb of ♀, × 70.

Tabanus corax, Lw.

This large species is a common one on the southern side of Mt. Mlanje in the more wooded areas within the belt of heavy rainfall. It is on the wing from the end of November to the beginning of January. There can be no doubt, especially

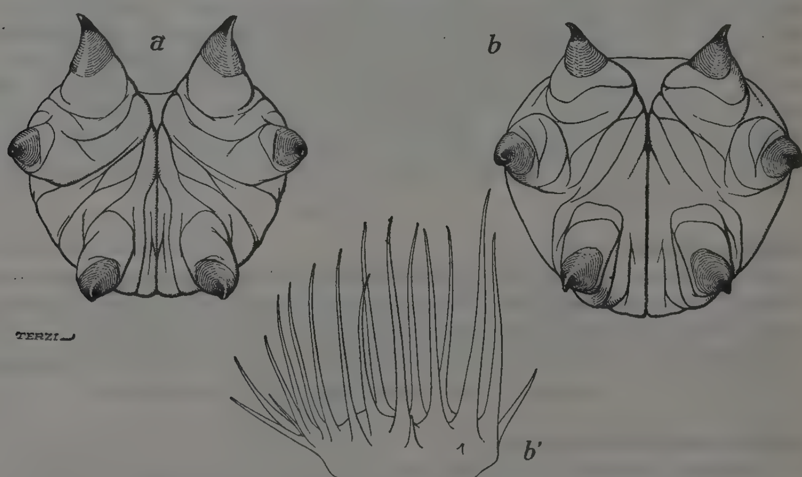


Fig. 18. *Tabanus corax*, Lw.; (*a*) pupal aster of ♂, × 35; (*b*) pupal aster of ♀, × 35; (*b'*) dorso-lateral comb of ♀, × 50.

now that this species has been bred, that the females described by Austen under the name *T. xanthomelas*, belong to this species. The males may easily be mistaken at first sight for those of *T. biguttatus*, Wied., but are distinguished by

the wing being uniformly dusky to the edge of the apex. The golden spots on the dorsal surface of the abdomen are nearly always smaller than those of *T. biguttatus*, and in specimens from Mlanje are not infrequently evanescent. The females of *T. corax* are interesting in that both a grey and a golden form occur, just as in the case of *T. biguttatus*.

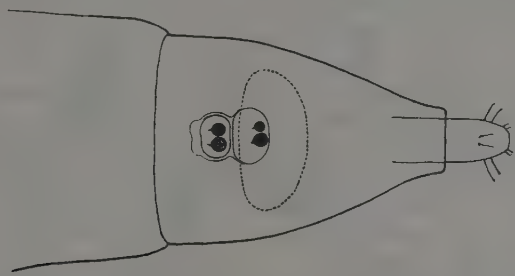


Fig. 19. Dorsal view of syphon and anal segment of a young larva of *T. corax*, Lw., showing Graber's organ ; the dotted line shows the position of the anus.

Considerable numbers of the larvae of this species were obtained. Adult specimens are very large (from 40–45 mm. in length) and very distinct, having a very thick, rough integument of a dull reddish colour, with a tendency to two more definite patches of darker red on the dorsal portions of the last two segments. The general coloration appears to be largely due to the presence of foreign bodies in the rough skin. The syphon is very short (Pl. xxvii, fig. 9). These larvae were most ferocious cannibals in all stages and very troublesome in the laboratory, as they seemed to have unlimited powers of wandering about, even over dry surfaces. They frequently succeeded in reaching the receptacles in which other species were kept, and in destroying the larvae in them.

In the pupal aster the dorsal hooks of the male are somewhat larger than those of the female. The dorso-lateral comb is large and composed of very long and fine spines.

A number of newly-hatched larvae of this species were obtained from collected egg-masses, generally found on reeds overhanging swampy ground. These grew very slowly at first. Fig. 19 is a diagrammatic sketch of the syphon and anal segment of one of these young larvae. It shows the peculiar Graber's organ, which is such a conspicuous object in most Tabanid larvae when examined in life under a lens. This remarkable organ is somewhat tongue-shaped or triangular and is attached by fine strands of muscle from each of the three corners, apparently to the body wall. It lies above the gut immediately below the dorsal integument, and seems to be capable of movement independent of the general body movements. This organ contains a number of pairs of small black pyriform bodies, which, as Mitzmain has pointed out, seem to increase in number with the age of the individual. The organ appears to be more elongated and to contain more pairs of these bodies in the *Chrysops* larvae that I have seen, than in any others.

Tabanus biguttatus, Wied.

This species is not very common in the vicinity of Mt. Mlanje, where the conditions are not specially suitable, as it prefers lower and drier country with sandy river beds. The capture of large numbers of the larvae in the Shire valley has already been recorded. Many others were subsequently found in the Ruo valley in November. The grey and fulvous forms of the female occur in about equal numbers in this part of Nyasaland.

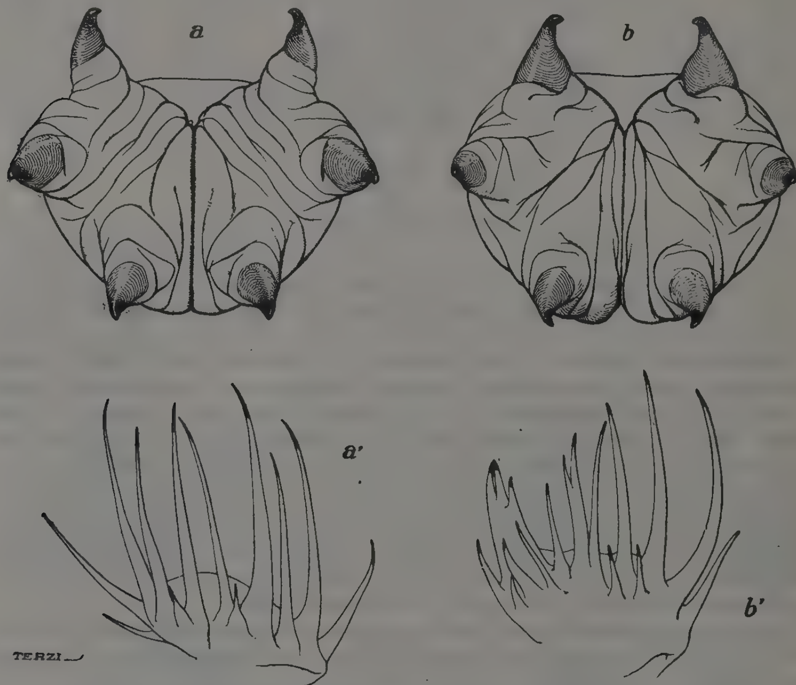


Fig. 20. *Tabanus biguttatus*, Wied. ; pupal aster (*a*) ♂, and (*b*) ♀, × 35 ; dorso-lateral comb of (*a′*) ♂, and (*b′*) ♀, × 50.

The larva is of a type which has many representatives, being of a clear white colour, except in individuals about to pupate, with well-defined pigmented bands and spots between the segments and on the anal segment (Pl. xxvii, fig. 8). Several species have larvae of this type, only varying in the amount of pigment and in the distribution of it on the anal segment.

The pupal aster is of the regular type and the dorso-lateral combs bear long spines, which are, however, shorter and stouter (especially in the ♀) than those of *T. corax*.

Tabanus ?secedens, Walk.

One female was taken in November 1912, and one male and three females in November 1913, of what appears to be a form of or perhaps a distinct species allied

to *T. secedens*, Walk. If the former is the case, the known range of this West African fly will have been very greatly extended, for on the eastern side of Africa it has hitherto been recorded only from Uganda.

Tabanus taeniola, P. de B.

As elsewhere in Tropical Africa, this is probably the commonest species of the genus in the Mlanje district, and though most numerous from October onwards, occasional specimens may be taken as late as April and May at the end of the rains. There is also reason to think that a second brood of this species may hatch about May in some parts of Nyasaland, though this was not the case at Mlanje itself during the year of my visit. The only flies of this genus found on the top of the plateau on Mt. Mlanje, at an elevation of 6,500 feet, seem to belong to this species. They are of the *variatus* form, but are considerably and uniformly darker than normal individuals. Several specimens of what is apparently another form of this species were taken in November, particularly in Portuguese territory. They resemble the typical form, as they lack any of the median dorsal triangles of *variatus*, but are very much smaller and very dark in colour. Some examples of this species were bred from larvae collected in Portuguese territory to the east of Mt. Mlanje early in October. As, however, the larva has been described and the pupa figured by Mr. H. H. King in the last part of this Bulletin they are not here dealt with in detail. The larva is chiefly remarkable for its very white colour and lack of pigment, and for the presence of a row of bristles immediately anterior to the anus. It is one of the most active and restless species I have had to deal with.

Tabanus ustus, Walk.

This species is not very common near the forested parts of the Mlanje district, but on the plains in Portuguese territory to the east, both sexes occurred in vast numbers in October; the males were then in the majority, the converse being the case

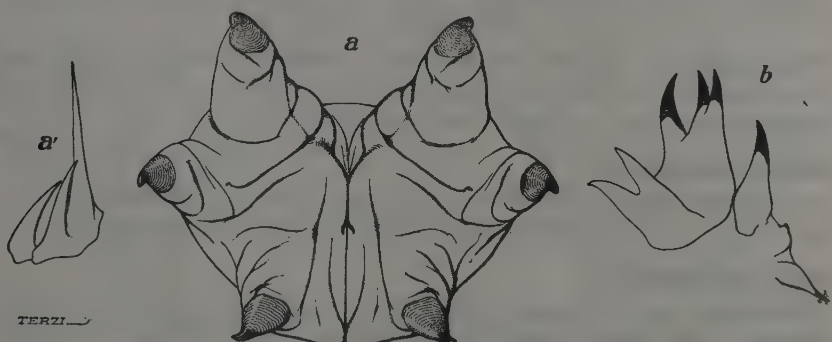


Fig. 21. *Tabanus ustus*, Walk.; (*a*) pupal aster of ♂, × 35; (*a′*) dorso-lateral comb of ♂, × 70; (*b*) dorso-lateral comb of ♀, × 70.

about a month later. Plate xxxi, fig. 1, shows a pool in a nearly dry stream bed, around which enormous numbers of freshly hatched males of this species occurred at the beginning of October. One male and three females were bred in the laboratory

at the end of October and beginning of November. The larva (Plate xxviii, fig. 14) resembles that of *T. biguttatus*, but is less pigmented.

The upper hooks of the pupal aster are considerably larger than the remainder. The spines of the dorso-lateral comb are much reduced, especially in the male.

Tabanus denshami, Aust.

This species occurs sparingly in the neighbourhood of Mt. Mlanje in October and November. It is commoner in the lower and drier ground lying out from the mountain. Like most Nyasaland and Rhodesian specimens, the abdominal markings are much less strongly developed than in examples from British East Africa and Uganda.

Tabanus fraternus, Macq.

This *Tabanus* is uncommon in so damp and well wooded a locality as Mt. Mlanje, though a single female was bred on 16th December 1914, from a locally collected larva, which was not recognised as distinct from that of *T. taeniola*.

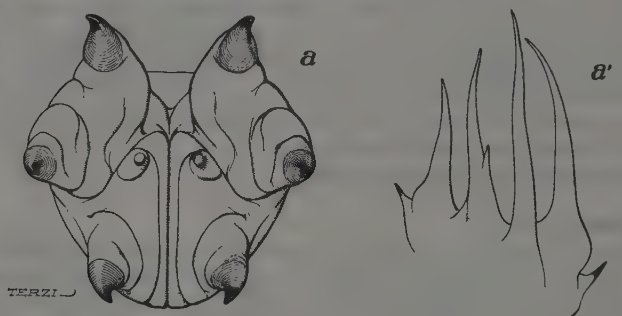


Fig. 22. *Tabanus fraternus*, Macq., ♀; (*a*) the pupal aster, × 35; (*b*) the dorso-lateral comb, × 70.

The pupal aster resembles that of *T. maculatissimus* in having a small papilla on each side of the middle line. The dorso-lateral comb consists of only a small number of spines, which, though rather long, are fairly stout.

Tabanus distinctus, Ric.

An uncommon species near Mt. Mlanje itself, as it prefers drier country. It was fairly numerous in Portuguese territory to the south and east of the mountain.

Tabanus coniformis, Ric.

This species is usually commonest in moderately open country and is therefore not abundant at Mt. Mlanje, though a large series was taken in the district, especially in Portuguese territory, in October.

Tabanus sandersoni, Aust.

This is a widely distributed but not very abundant species near Mt. Mlanje, and is one of the latest species of the genus, occurring from January to April. It is not uncommonly taken towards dusk, which is not usual among flies of this genus.

Tabanus nigrostriatus, Aust.

A few females of this species, mostly somewhat worn, were taken near Lake Chilwa, in January 1914, from which it would appear to be an early mid-season species. The males, as might have been expected, were not then obtainable.

Tabanus barclayi, Aust.

This species was not taken at Mt. Mlanje itself, but occurs sparingly in Portuguese territory to the east of the mountain, and to the north, near Lake Chilwa.

Tabanus sticticollis, Surc.

A small series of 7 males and 13 females, apparently belonging to this species, were taken near Mlanje, in November and December only, both in 1912 and 1913. They were mostly captured in rather open country away from the forest.

The eyes of the ♂ are bronze above with greyish reflections, and dusky below.

Tabanus unitaeniatus, Ric.

This insect was seen on only one occasion in the Mlanje district, a single female being taken on the northern boundary, the Palombe River, near Lake Chilwa, in January 1914. The eyes are dusky and unicolorous, thus distinguishing it at once from *T. laverani*, which it otherwise somewhat resembles.

Tabanus atrimanus, Lw.

This is a common species near Mt. Mlanje, as might be expected owing to its pre-preference for the neighbourhood of wooded streams. It is most abundant in November and December.

On 25th October a number of the larvae were taken in the Ruo River (Plate xxix, fig. 2) amongst the roots of grasses in running water, but occasional individuals were also found in the mud in other wooded streams. Imagines, bred from these, began to

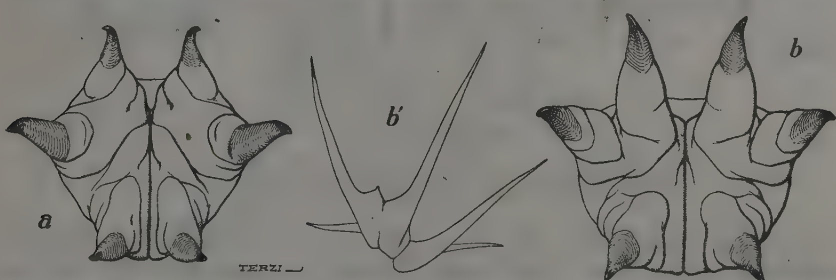


Fig. 23. *Tabanus atrimanus*, Lw. ; (*a*) pupal aster of ♂, × 35 ; (*b*) pupal aster of ♀ ; (*b′*) dorso-lateral comb of ♀, × 70.

emerge on November 25th. At the same spot in the Ruo River some other larvae were found which may be those of *T. pertinens*, but they were not bred through. The larvae (Plate xxviii, fig. 15) are strikingly distinct from those of the apparently closely allied *T. variabilis*, Lw. They are of a somewhat opaque yellowish colour, with rather faint brown pigmented areas. The pseudopodia are well developed,

as is the case with other species found in running water, and there are well-marked hairs on the syphon. Though invisible in preserved specimens, two pseudopodia of considerable length are present immediately anterior to the anus. The pupa is a clear orange-yellow colour and the aster is remarkable for the erectness and large size of the dorsal pair of hooks, especially in the female. The dorso-lateral comb consists of a few fine widely spread spines.

I find that I was mistaken in a former paper (*loc. cit.* p. 296) in describing the eyes as dusky purplish. The ground-colour is as described, but it is crossed in the female eye by two narrow bars of greenish iridescence, one such bar being present in the lower small-facetted area of the male eye.

Tabanus variabilis, Lw.

This species is not a rare one near Mt. Mlanje, though not so common as the preceding. It occurs on the wooded streams in the neighbourhood of the mountain in October and November, occasionally later. The larvae (Plate xxviii, fig. 17) were found in some abundance in these localities. They are entirely different from those of *T. atrimanus*, being almost colourless, though in quite mature individuals the base of the syphon and the syphon itself are of an orange colour. The most striking peculiarity of this larva is, however, the presence of a distinct papilla of a dark colour on each side of the anal segment. This is easily recognisable in life and distinguishes this species from any other I have yet seen. The anus is also unusually prominent.

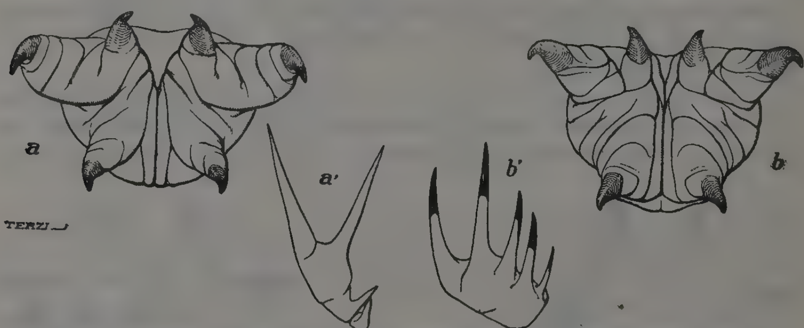


Fig. 24. *Tabanus variabilis*, Lw. ; (*a*, *a′*) pupal aster and dorso-lateral comb of ♂ ; (*b*, *b′*) pupal aster and dorso-lateral comb of ♀.

The pupa (Plate xxviii, fig. 16) is also remarkable for its dark coloration, especially on the dorsum of the thorax. The aster is characterised by the large, horizontally extended middle pair of hooks, and its outline is therefore entirely different from that of the closely allied *T. atrimanus*. The dorso-lateral comb consists of a few short and rather stout spines.

Tabanus insignis, Lw.

A large series of flies resembling this species was obtained, accompanied by an equally large number of individuals identical with the type of *T. sharpei*, Aust., and a great variety of intermediates between the two. In addition, a small series was

bred from the very characteristic larvae (Plate xxviii, fig. 10), in which both types are represented. It would seem therefore that, though the name *sharpei* may be retained for the forms with a marked reduction of abdominal spots, they probably do not represent a distinct species from *T. insignis*. This fly is abundant

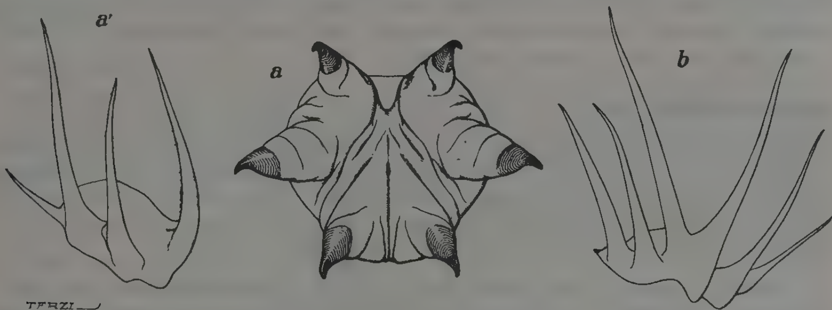


Fig. 25. *Tabanus insignis*, Lw.; (*a*) pupal aster of ♂, × 35; (*a'*) dorso-lateral comb of ♂, × 140; (*b*) dorso-lateral comb of ♀.

near Mt. Mlanje from November onwards and individuals occur up to March. The very characteristic and strikingly pigmented larva was common in the mud of the forested streams from the end of September. It may be distinguished at a glance from other similarly pigmented species by the white trefoil-shaped area on the dorsum of the anal segment. This is a very voracious and predaceous larva and troublesome to keep in the laboratory for that reason. The pupal aster is of the normal type, the spines of the dorso-lateral comb being few in number, but somewhat long.

Tabanus laverani, Surc.

A rare species at or near Mlanje, and only occasional specimens were taken. The eyes resemble those of *T. gratus*, but the green band in the lower portion of the

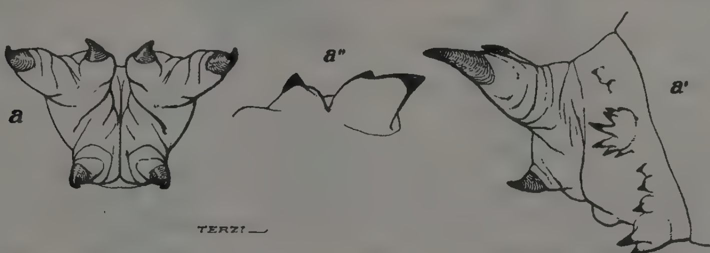


Fig. 26. *Tabanus laverani*, Surc., ♂; (*a*) pupal aster, × 35; (*a'*) pupal aster from the side, showing the combs and the small dorso-lateral comb, × 35; (*a''*) much enlarged view of dorso-lateral comb.

eye of the male is broader and somewhat curved at the ends, not straight as in *T. gratus*. A single female was bred on 25th November 1913, from a larva collected near my headquarters. This larva did not belong to the pigmented type like that

of *T. gratus* and resembled the larva of *T. variabilis* in bearing lateral pseudopodia on the anal segment. It was, however, of a yellower colour and less transparent than that species, and lacked any pigmentation on the syphon.

The pupal aster is remarkable for the great size and elongation horizontally of the middle pair of hooks. The dorso-lateral comb is reduced to two very short processes, the main combs on the last segment being also of this character, as may be seen from the view in profile (fig. 26, *a'*).

Tabanus pertinens, Aust.

This fly, which is usually confined to comparatively low-lying country where the river beds are of a sandy nature, does not occur at Mt. Mlanje itself, though a few specimens were taken at some distance from the mountain, particularly to the south, on the Kola River in Portuguese territory. It was not uncommon on the Mwanza River, in the Shire valley, as early as the end of July.

A pigmented larva (Plate xxviii, fig. 11), which it is thought may belong to this species, was taken in some numbers in the Shire River in August, and in the Ruo River in October. It was found in both cases in water amongst the roots of grasses or water-plants, and seems to prefer rivers with a sandy bottom and banks. The striking larva is remarkable for the development of the dorsal pseudopodia, which perhaps are associated with its comparatively free-swimming existence. Two pseudopodia are also present immediately anterior to the anus.

Tabanus nagamiensis, Carter.

This recently described species is represented by a single female captured on the Malosa River, the Anglo-Portuguese boundary south of Mt. Mlanje, on the 8th October 1913, and by a male bred from a collected pupa on 27th September 1913, so that it would appear to be an uncommon species in this locality. The eyes

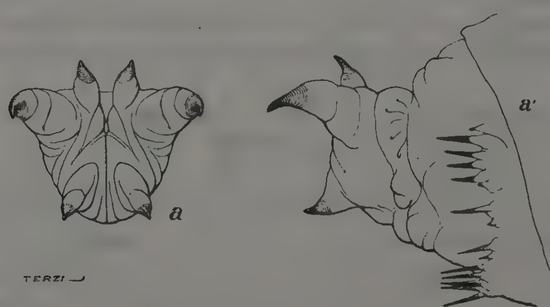


Fig. 27. *Tabanus nagamiensis*, Cart., ♂; (*a*) pupal aster, × 35; (*a'*) pupal aster from the side, showing combs, the dorso-lateral comb being absent.

of this fly in the female are of a reddish-purple colour, crossed with two bands of green slightly outlined in yellow. In the male the large upper facets are purplish-brown, with a narrow line of greenish on the lower margin; the lower facets are dull purplish, with a single greenish band narrowly outlined in scarlet.

The pupal aster somewhat resembles that of *T. laverani* in the great development of the middle pair of hooks. The dorso-lateral comb is absent, a character I have not yet seen in the pupa of other species of *Tabanus*, except in *T. medionotatus*. The other combs are, however, striking and characteristic, as may be seen from the figure.

Tabanus diversus, Ric.

A considerable series of females of this species was taken in October in the flat country east of Mt. Mlanje over the Portuguese border. The eyes in living individuals are somewhat peculiar, as they are dusky with a slight greenish iridescence and a well-marked patch of purple iridescence near the upper margin, which does not, as is usually the case, vary with the position in which the eye is examined. This is evidently an early species of *Tabanus*, as these females had certainly emerged some time and the males were over. The only males which I have seen were taken in Northern Rhodesia, near Fort Jameson, on a previous expedition toward the end of September.

Tabanus gratus, Lw.

This is a very common species and one of the earliest on the wing in Nyasaland, occurring sometimes in August. Larvae and pupae were collected in this month, the first individual emerging in the laboratory on 1st September. The larva (Plate xxviii, fig. 12) is moderately pigmented, though, compared with that of

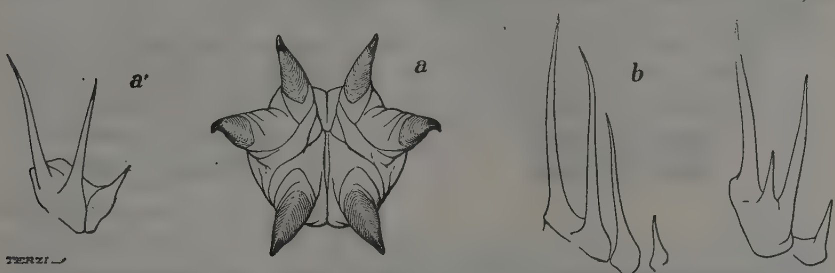


Fig. 28. *Tabanus gratus*, Lw.; (*a*) pupal aster of ♂, × 35; (*a'*) dorso-lateral comb of ♂, × 70; (*b*, *b'*) dorso-lateral comb of ♀, in two different individuals.

T. insignis, the pigmented areas are nearly confined to the edges of the segments and are not nearly so dark in colour. The syphon is somewhat longer than in that species. A few larvae were obtained in the stream beds near Mt. Mlanje and a small series in Portuguese territory to the east of the mountain early in October.

The pupal aster is of the normal type, being regular in outline. The spines of the dorso-lateral comb are much reduced, especially in the male.

Tabanus leucostomus, Lw.

I did not take this species near Mlanje, as it seems to prefer rivers with sandy beds in somewhat open country. It was found sparingly on the Mwanza River in July and also on the Kola River, Portuguese East Africa, in April.

Tabanus claritibialis, Ric.

This species was found in considerable numbers in January between Mt. Mlanje and Lake Chilwa. It had then evidently been on the wing some little time, as the females were biting readily and no males were obtainable.

Tabanus thoracinus, P. de B.

Occasional individuals of what appear to be this species, which is distinguished at a glance in life from *T. obscuripes* in having green eyes instead of brownish-purple ones, were captured at Mlanje between October and January. In other respects they more resemble *T. obscuripes*, and further material may prove that though normal individuals of that species have brownish-purple eyes, occasional specimens have the eyes green like those of *T. thoracinus*.

Tabanus obscuripes, Ric.

This species occurred in some numbers in October and November, but was less common near Mlanje itself than on the plains in Portuguese territory to the east and south. In the majority of typical examples the eyes of the female of this species are brownish-purple, but in these Mlanje specimens a few individuals had green eyes

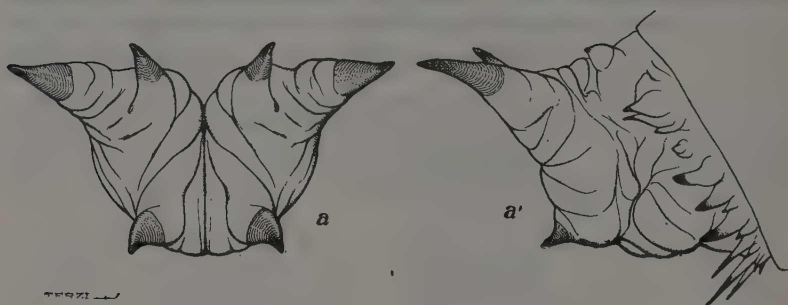


Fig. 29. *Tabanus obscuripes*, Ric., ♂; (*a*) pupal aster, × 35; (*a.*) profile of last segment of pupa, × 35.

like those of *T. thoracinus*, though not differing in other ways. A single male was bred from a collected pupa on the 1st October. The pupal aster somewhat resembles that of *T. laverani* and has the same very large middle pair of hooks. The dorso-lateral comb is reduced to a single knob-like process.

Tabanus par, Walk.

Though never a common insect in the Mlanje district, occasional specimens of this species were taken over a wide area from October to January.

Tabanus medionotatus, Aust.

A series was obtained comprising a single male and a large number of females which are attributable with some doubt to this species. They are readily distinguishable

from *T. par* by having brown, not green eyes. The eyes of the male are yellowish, slightly translucent, and with a single apparently deep-seated spot. Five males and three females were bred between the end of September and the beginning of November. The pale-coloured larva has rather long pseudopodia, a ring of pigment of varying

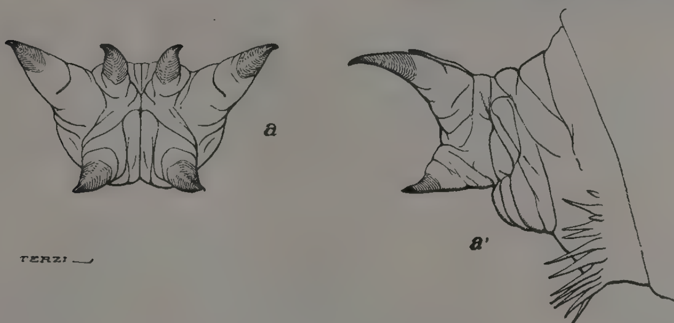


Fig. 30. *Tabanus medionotatus*, Aust., ♂; (*a*) pupal aster, × 35; (*a'*) profile of last segment of pupa, × 35.

width round the base of the syphon (Plate xxviii, fig. 13), and another ring round the anus, which is unusually prominent in the living larvae. There are also present two pseudopodia immediately anterior to the anus, but these are not visible in the somewhat contracted preserved specimen and therefore are not shown in the figure.

The pupal aster resembles that of *T. obscuripes* in having a large and even longer, but less horizontal, middle pair of hooks. Not only the dorso-lateral, but most of the lateral, comb is absent.

Tabanus ditaeniatus, Macq.

This is one of the mid-season species in Nyasaland, *i.e.*, it is not on the wing until January, a month or more after the beginning of the rains. It was found in some numbers in rather open country to the north of Mt. Mlanje, especially near the south and south-west shores of Lake Chilwa.

Though there is considerable general resemblance between this species and *T. fuscipes*, Ric., there can be no question that they are distinct. The males of *ditaeniatus* are larger than those of *fuscipes* and are much less hairy insects, with a paler thorax and abdomen. The eyes of the two species are similar in this sex, but the upper large facets of *fuscipes* are of a somewhat greener colour and less translucent. The females are distinguished, *inter alia*, by those of *ditaeniatus* being very much paler on the underside, especially of the abdomen. In both species, the yellowish translucent eyes are horizontally by a narrow line of a purplish colour.

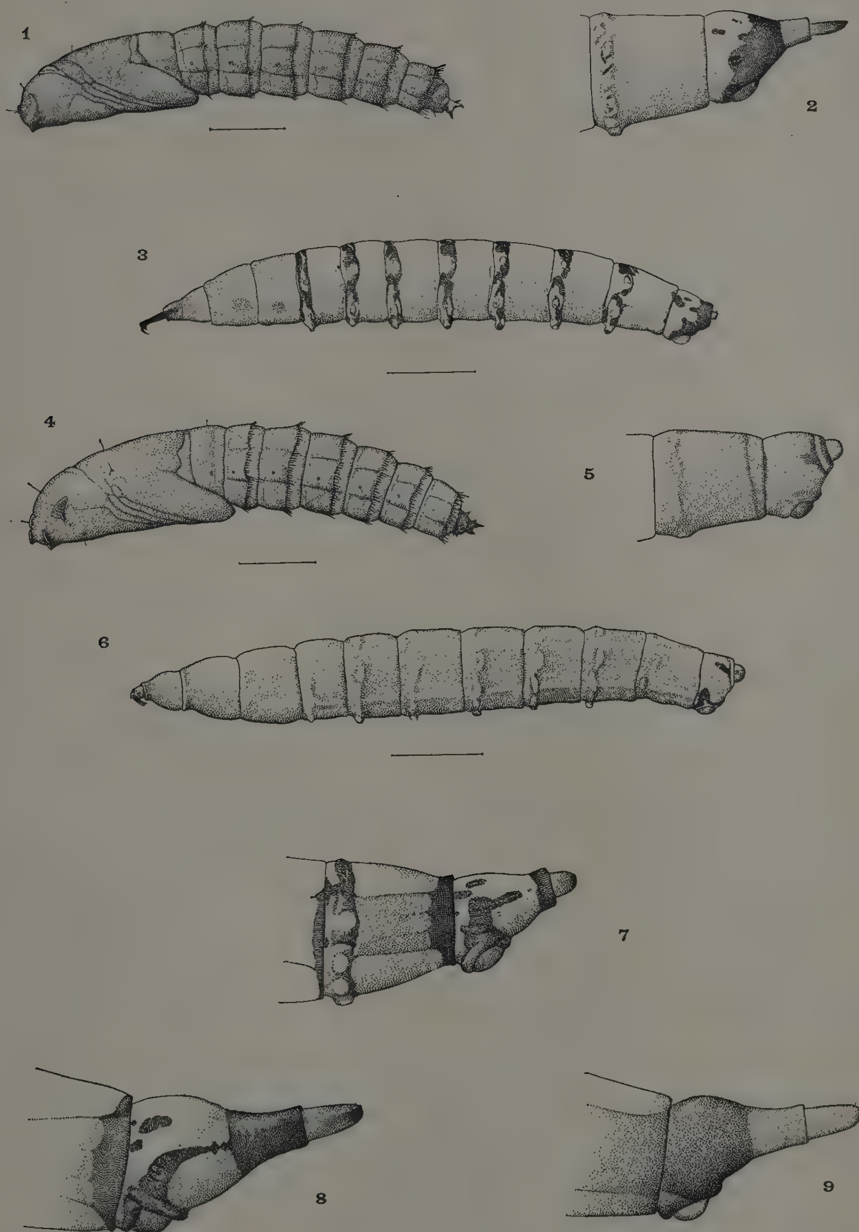
Tabanus fuscipes, Ric.

This species resembles the foregoing in its habits, time of emergence, etc., though it has a far more restricted range. Newly-emerged examples of both species were

captured near Lake Chilwa in January 1914, in circumstances which render it extremely probable that they had bred in mud some considerable distance from water, which had been hard and dry for some portion at any rate of the dry season. I am inclined to think that in the case of these and other mid-season species, such as *T. claritibialis*, Ric., and *T. sandersoni*, Aust., that the larvae hibernate fully fed at the beginning of the dry season and only pupate when the next season's rains release them from the hard ground.

Explanation of Plate XXVII.

Fig. 1.	*Chrysops longicornis*, Macq.	..	pupa. × 6.
2.	,, ,,	..	syphon of larva. × 10.
3.	,, *wellmani*, Aust.	..	larva. × $6\frac{1}{2}$.
4.	*Haematopota insatiabilis*, Aust.		pupa. × 6.
5.	,, ,,		syphon of larva. × 10.
6.	,, *crudelis*, Aust.	..	larva. × $6\frac{1}{2}$.
7.	*Tabanus maculatissimus*, Macq.		syphon of larva. × 9.
8.	,, *biguttatus*, Wied.	..	syphon of larva. × 9.
9.	,, *corax*, Lw. ..	..	syphon of larva. × 9.

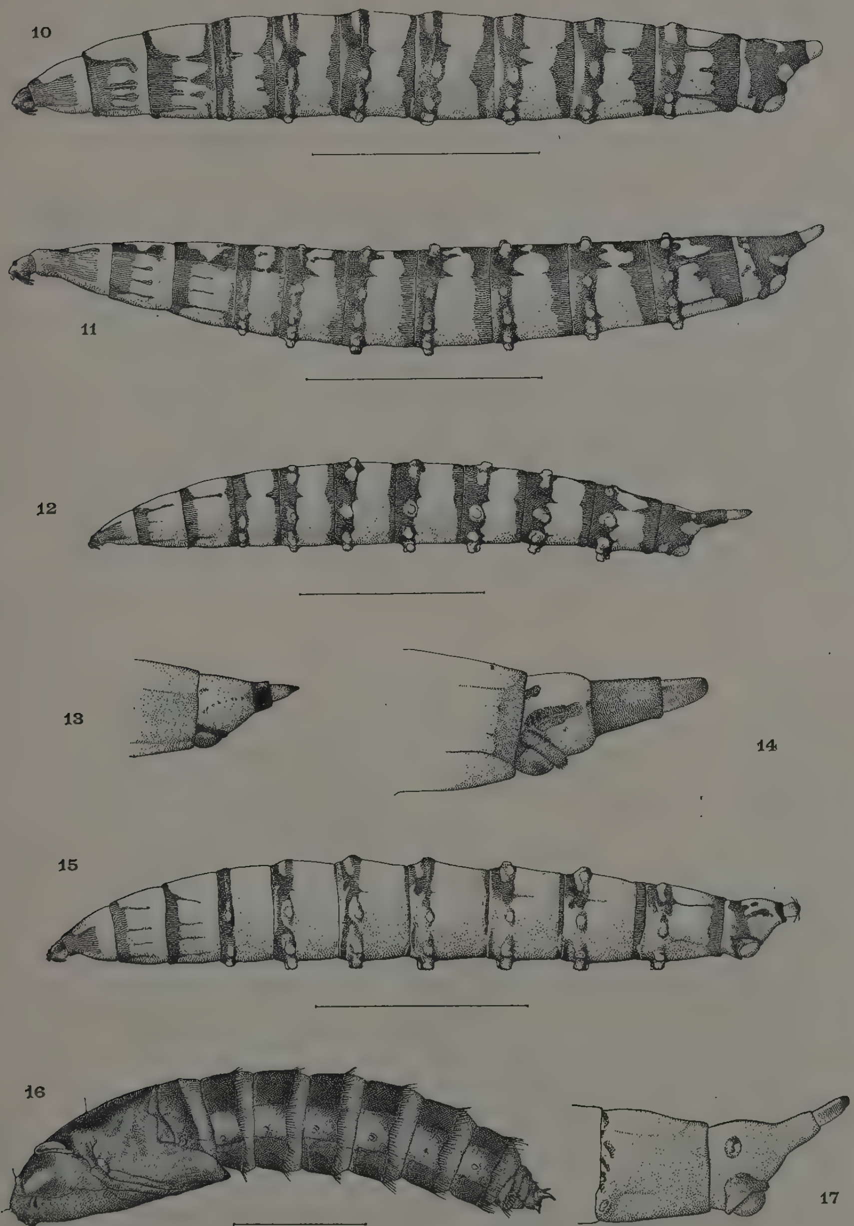


A. J. E. Terzi. del

EARLY STAGES OF EAST AFRICAN TABANIDÆ.

Explanation of Plate XXVIII.

Fig. 10.	*Tabanus*	*insignis*, Lw.	.. larva. × $3\frac{1}{2}$.
11.	,,	*pertinens*, Aust.	.. supposed larva. × $3\frac{1}{2}$.
12.	,,	*gratus*, Lw. ..	.. larva. × $3\frac{1}{2}$.
13.	,,	*medionotatus*, Aust.	.. syphon of larva. × 9.
14.	,,	*ustus*, Walk.	.. syphon of larva. × 9.
15.	,,	*atrimanus*, Lw.	.. larva. × $3\frac{1}{2}$.
16.	,,	*variabilis*, Lw.	.. pupa. × 4.
17.	,,	,,	.. syphon of larva. × 9.



A. J. E. TERZI, DEL.

EARLY STAGES OF EAST AFRICAN TABANIDÆ

Fig. 1. Characteristic view of the Lower Shire River. The larvæ of *T. biguttatus* were found in the sand-bank to the left of the picture.

Fig. 2. The Ruo River. The larvæ of *T. atrimanus* and ? *T. pertinens* were found in the running water amongst the grasses on the island. Large numbers of *Silvius apiformis*, sp. n., were taken at this spot.

Fig. 1. A small marsh, the site of the first captures of the larvæ and pupæ of *Chrysops longicornis*. Note somewhat open country and woodland, *not* forest.

Fig. 2. Part of the bed of a forest stream where the larvæ and pupæ of many forest-haunting Tabanidæ were found.

Fig. 1. Bisenti, my head collector, at a pool in the bed of a dried-up river. Vast numbers of freshly emerged Tabanidæ were coming to drink at this pool, especially the males of *T. ustus*. The larvæ of *T. maculatissimus*, *T. tæniola* and *T. gratus* were found here.

Fig. 2. The collecting staff.

THE COMPARATIVE MORPHOLOGY OF THE ANOPHELINES *NYSSOMYZOMYIA LUDLOWI*, THEO., AND *N. ROSSI*, GILES.

By C. Strickland, M.A., B.C.,
Travelling Medical Entomologist, Federated Malay States.

(Plates XXXII and XXXIII.)

As some confusion exist in the minds of medical men in the Malay States as to the differentiation of the Anophelines *ludlowi* and *rossi*,* it is probably worth while to give the following comparative notes of the two species, particularly as I believe that the larva of *ludlowi* has been previously held to be indistinguishable from *rossi*, whereas it is in reality very distinct.

The material was taken at Morib, Selangor, to which place I was sent in connection with an outbreak of fever; and the figures have been drawn with the aid of a camera lucida attached to a Zeiss binocular dissecting microscope.

The Egg.

The egg was studied in specimens both laid by mosquitos, and taken from their ovaries when ripe.

In estimating the comparative size of ova it must be borne in mind that when using the microscope optical sections at the same plane must be compared.

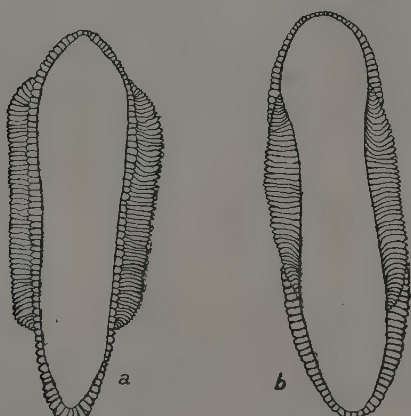


Fig. 1. Eggs of: *a*, *Nyssomyzomyia ludlowi*; *b*, *N. rossi.*

Perhaps the best way to effect this is to rack the focussing adjustment up-and-down until the greatest length of the opaque part of the egg is seen in the species to be compared; the frilled cuticle can be disregarded because it seems to be variable

* Our so-called *rossi* may prove to be distinct from *rossi*, Giles.

in thickness even at the same plane. Likewise, the broadest part of the float should be taken for comparative tests. The frilled cuticle varies in thickness when seen under the microscope, possibly owing to foreshortening over different regions of the egg, being especially thick at the prow and stern points. If these precautions are not taken, it may appear that two species have different characters in the ova, when they may actually be similar.

It may be mentioned here that we think the usual statement that the floats of the egg contain air is not correct. What seems to be actually the case is that the frilled cuticle, as well as the floats, merely serve to attach a thin film of air *on their surface* when placed dry on water. When in the egg-sac the eggs are immersed in the body fluids, and so when placed in water the water can permeate directly into all the crannies of the cuticle, no surface film of air forms, and the egg sinks.

We found the eggs of the two species indistinguishable in structure and of practically the same size. The length of the opaque portion of the egg was the same in both cases, the floats were equally broad and the frills of the float similar in size, and the frilled cuticle also similar in both cases (fig. 1).

The Larva.

In both species we observed the phenomenon recorded by Stanton (1911), that the palmate hairs exist at first as merely buds which finally open up. The leaflets of the young larva are always more cylindrical than those of the older specimens, which are much jagged at the shoulder just below the origin of the filament, so that in comparing two species larvae of about the same size should be taken.

We observe the following differences in well-grown larvae :—

1. *N. rossi* has its frontal hairs as described by Stanton (fig. 2, *b*); the internal anterior hairs are excessively long and filamentous; the external anterior rather variable in length in different individuals, but usually not much more than a

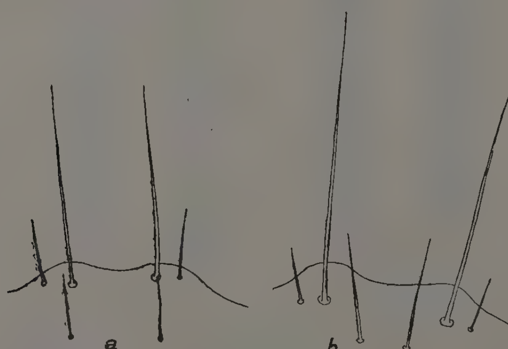


Fig. 2. The clypeal hairs of full-grown larvae of: *a*, *Nyssomyzomyia ludlowi*; *b*, *N. rossi*.

quarter the length of the former; while the posterior, as Stanton first pointed out, lie considerably *within* the anterior internal, projecting over the clypeus. On the other hand, in *ludlowi* the anterior internal hairs are not so excessively long and

filamentous, while the posterior *invariably* lie almost in a direct line behind or even external to them ; they are much finer than in *rossi*, and do not reach further than about the point of origin of the anterior internal hairs (fig. 2, *a*).

2. The palmate hairs of *ludlowi* are rudimentary on the first abdominal segment, and well-developed from the second to the seventh. In *rossi* they are similar.

3. The relative length of the filament to the leaflet in *ludlowi* is a little less than in *rossi*, but the distinction is too fine to be of any practical use.

The larva of *ludlowi* is therefore quite distinct from that of *rossi*.*

The Pupa.

We have examined the empty pupa-cases of the two species, and could detect no difference between them.

The Imago.

In the adult stage we find :—

1. Different palpal banding in the two species (Plates xxxii and xxxiii), *ludlowi* having a terminal white band succeeded by a black band of nearly equal width, whereafter is another narrow white band ; *rossi* having a terminal white band of much greater absolute length than the terminal band in *ludlowi*, succeeded by a very narrow black band, and this by another white band of similar width to the black band.

2. The size of the mosquito differs. The male of each species is bigger than the female, but the comparative size of the two species, sex for sex, can be judged from the figures. I think the two species can be diagnosed with the naked eye by their size alone.

3. The general impression of *ludlowi* is of a spotted black object, rather like *fuliginosus* in this respect, but *rossi* is very light-coloured—in fact, with the exception of *kochi*, it is perhaps the lightest coloured mosquito we have.

4. The leg marking differs ; *ludlowi* is as spotted as *maculatus*, with the distinction that the spots are golden, and this is due to scaling ; whereas in *rossi* there is nothing more than a little tawny mottling due to the black leg scales not completely covering the chitin beneath.

With regard to the imago, it need only be said that in a series of 255 which we examined there was never a fly which could not be referred to the one species or the other. I think the confusion which exists in the minds of medical men in this country is due to two factors :—(1) That the palps when being examined have been foreshortened and the true relation of the palpal bands is not seen ; and (2) that

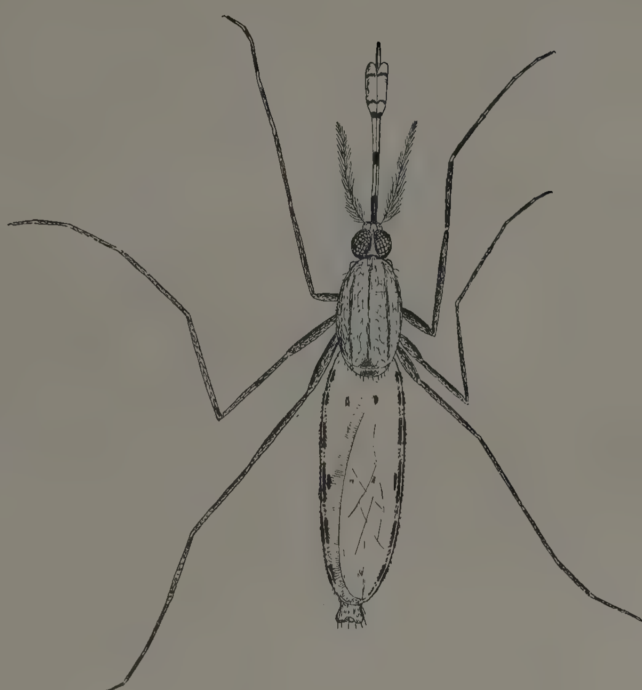
* As a certain amount of confirmation we may note that if either *ludlowi* or *rossi* had hatched out in our breeding bottles, on examining the larvae remaining in the bottles, we found in *every* case, although we need not have expected such favourable evidence, that they were of the type which we now ascribe to the respective species.

In young larvae the distinction between the two species is very fine, and could not be relied on for practical purposes. The similarity is due to the posterior hairs in *rossi* being placed far apart and further back, much as in *ludlowi*.

old specimens of *ludlowi* lose the lustre in the leg spotting, and this is then much less distinct, while, on the other hand, the tawny mottling which exists in *rossi* is rather increased in dry specimens, owing partly to contraction of the scales over the tawny-coloured leg and partly to denudation.

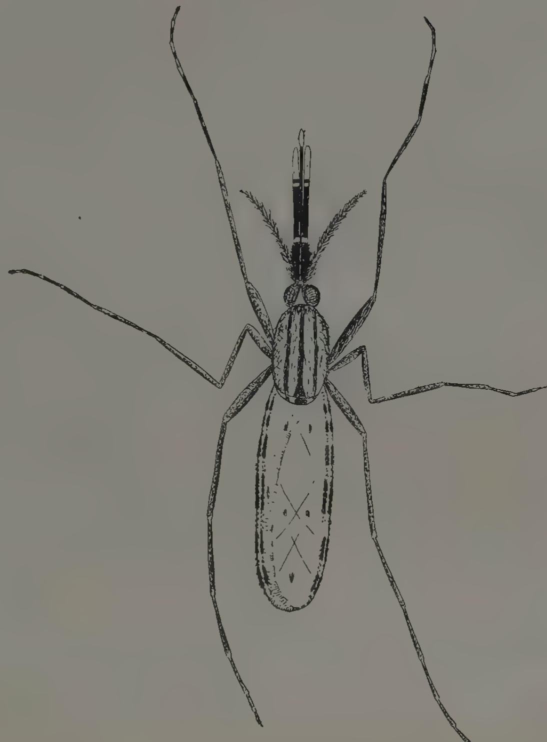
We thus see that the two species, *ludlowi* and *rossi*, can be readily distinguished in either the well-grown larval or imaginal stage. It is satisfactory that this is so with regard to the larva, for the identification of the larva in the field saves much trouble and is preferable, if feasible, to breeding out the imago.

The Malaria Bureau,
Kuala Lumpur, F.M.S.

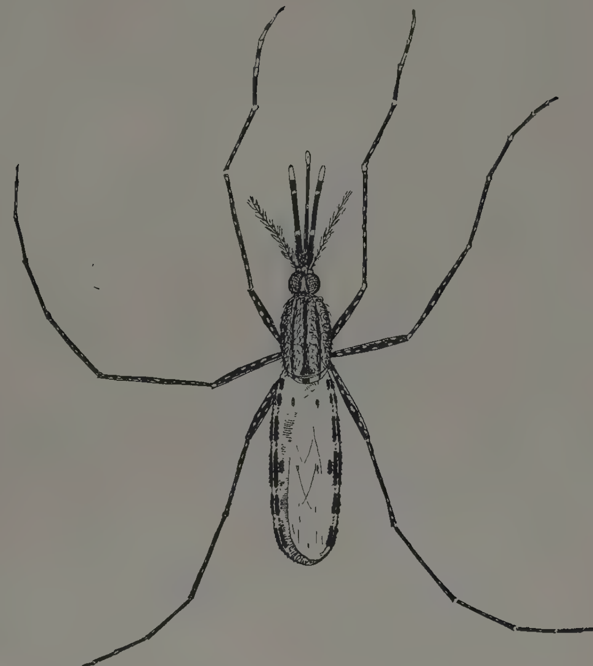


Nyssomyzomyia rossi, Giles, ♂.

Nyssomyzomyia ludlowi, Theo., ♂.



Nyssomyzomyia rossi, Giles, ♀.



Nyssomyzomyia ludlowi, Theo., ♀.

NEW SPECIES OF CHALCIDOIDEA FROM CEYLON.

By James Waterston, B.D., B.Sc.,

Imperial Bureau of Entomology, London.

All the species described in this paper were obtained at Peradeniya, Ceylon, by Mr. A. Rutherford, the Government Entomologist, and were forwarded by him to the Imperial Bureau of Entomology for identification. In every case the types are deposited in the British Museum.

Genus Polycystus, Westwood.

Polycystus propinquus, sp. nov.

Very near to *P. luteipes*, How. (Journ. Linn. Soc. Lond., Zool., xxvi, p. 142, 1896), from which, however, it differs as detailed below, in its slightly smaller size, puncturation and antennal structure. A bronzy green species with entirely luteous legs.

♂.—*Head* just wider than the thorax, dark metallic green with cupreous or bronzy reflections, surface moderately coarsely punctured. Clypeal edge straight, medianly incised, with an inconspicuous tooth on each side of the incision.

Antennae inserted nearly at the base of the eye, with dark base; scape long, slender, entirely pale, reaching to beyond the anterior ocellus; pedicel longer than the ring joints and the first of the funicle together; two small ring joints, the second slightly larger, first joint of funicle shortest, about three-quarters of the second; the six funicular joints are almost transverse and increase gradually in breadth so that the club is little wider than the preceding joint. In *luteipes* the joints of the funicle are more cylindrical (one being nearly equal to two) and the club broader; in *luteipes* the club and two joints before it, in *propinquus* the club alone, are darkened.

Thorax coloured like the head. Puncturation or raised reticulation strong, coarser on mid lobe of mesothorax than in *luteipes*. The parapsidal furrows reach the border of the scutellum, but are more delicate posteriorly than in *luteipes*. Suture between pro- and meso-thorax broad and gleaming. Metanotum smooth and shining. Propodaeum with a median carina and indistinct lateral folds. Spiracle about mid-way on anterior edge between median carina and the fold.

Abdomen: Petiole reticulate, with faint median and lateral carinae; colour, purplish black, dull. Abdominal segments smooth, dark, gleaming, the whole triangularly expanded; second segment largest, the others telescoped.

Legs: Coxae dark, metallic, the fore pair nearly smooth, greenish; the posterior rather purplish and rougher. Mesopleural impression completely and coarsely reticulate. Legs entirely pale honey-yellow, except the last tarsal joints (fifth) and the claws, which are dark.

Length, 1½ mm.; alar expanse, 3¼mm.

Host: the bean fly (*Agromyza phaseoli*, Coq.).

Described from a single male.

Genus Trigonogastra, Ashmead.

The two Sphegigasterines described below agree in having the petiole longer than the coxae, distinctly in the females and slightly in the males, the parapsidal furrows incomplete, no apical cross furrow on the scutellum and the long propodaeum punctate. In all the pronotum is truncate and the upper edge acute. Ashmead, in diagnosing the genus (Mem. Carn. Mus., i, no. 4, pp. 330–332, 1904), gives as type *T. aurata*, a species I have been unable to trace. *T. rugosa*, sp. n., and
a *T. megacephal~~us,~~* sp. n., may be separated at once by the antennae. The former is a green, the latter a dull purplish black species.

Trigonogastra rugosa, sp. nov. (fig. 1).

A moderately and evenly shagreened or reticulate species, with the head, thorax and propodaeum very dark green; the abdomen shining blackish, with a paler brown median area (in the ♂ only) on the first and second segments; legs brownish yellow with darker tarsi; antennae with the scape lighter, remaining joints darker brown.

♂.—*Head* large, seen from in front, rounded at the sides, broader than deep, though descending with a large malar space to the mouth edge. Vertex so wide as to equal the thorax on the intraorbital diameter alone; ocellar triangle distinctly elevated, occupying a little over the central third of the vertex; no occipital ridge, the vertex and occiput merging roundly into one another. Frons concave, dull, gleaming, with rather fine reticulation as on the vertex; scrobes oval, antennae set on the mid diameter between the eyes, and well above the middle of the frons; the mid point of the scape is at or above the ocelli. Clypeal edge with two slight rounded lobes.

Antennae (fig. 1, *a*) long and filiform and of practically the same breadth throughout, the club being little expanded. Thirteen joints: scape, pedicel, two ring joints, seven funicular, and club of two. Scape as long as the pedicel, the ring joints, the first funicular and half of the second, together; flavescent brown in colour, with about half-a-dozen short bristles along the dorsal edge and one or two ventrally, otherwise bare, broadest before the apex, the breadth about one-sixth of the length of the scape. Ring joints distinct and separate, the second robust, darker, and half as long again as the first. Funicle and club blackish brown; the funicular joints decreasing in length towards the club; the first is longest, slightly exceeding the second, which equals the third, the fifth and sixth again being equal; the seventh (eleventh) is the shortest of all, being to the first in the ratio of five to seven; the club joints are equal. The funicle and club bear elongated "sensoria" with low flanges, and each joint shows besides up to fifty or more longish hairs, giving the whole antenna a pilose appearance. Length of antenna, 1·5 mm.

Mandibles (fig. 1, *c*) heterodont, the right with four teeth, of which the outermost is the most acute and longest, the second smaller, and the third and fourth equal; left with three equal teeth, the outermost more acute.

Thorax with incomplete parapsidal furrows, and evenly reticulate, of about the same coarseness as the head, slightly coarser on scutellum. Propodaeum as long as the scutellum, and with only slightly finer reticulation, transverse, with posteriorly convergent sides; produced behind broadly into a neck, so that the whole segment from above is roughly a truncate triangle. There is an indefinite median ridge and a rather extensive sulcus anteriorly on each side behind the metathoracic edge. Spiracles small, oval.

Fore wings, two-and-a-half times as long as broad. Submarginal cell long and narrow with about a dozen bristles. Submarginal vein with about twelve to fourteen bristles, marginal, and post-marginal combined, with about the same number of bristles. Radius long, club distinct, four cells. There is, besides the bare basal triangle, an unclothed space below the uprise of the submarginal to the marginal. Submarginal: marginal: radius: post-marginal—10 : 4 : 3 : 6. Length, 1·35 mm., breadth, ·55 mm. Hind wings: length, ·96 mm.; breadth, ·16 mm.

Legs : all coxae black, from the trochanter to the second tarsal joint in all the legs brownish yellow, the last tarsal joints becoming progressively browner.

Abdomen : short, much less than the thorax, triangular. First and second tergites closely associated, occupying about one-half of the visible surface; tergite 3 rather long, about equal to 2; the remainder of the segments are telescoped.

Length, 1·3 mm.; alar expanse, about $2\frac{1}{2}$ mm.

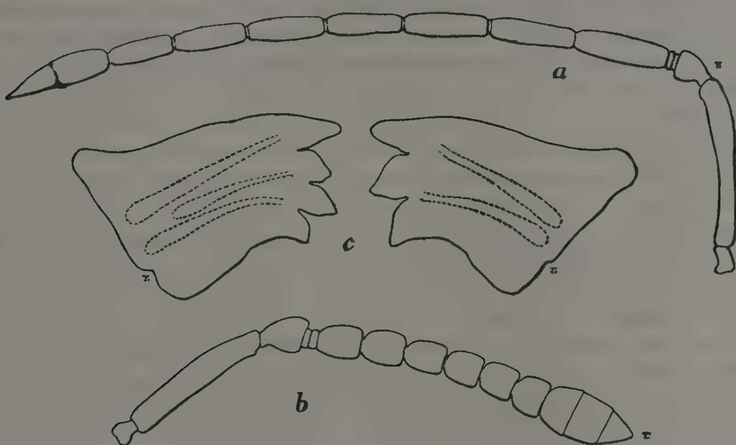


Fig. 1. *Trigonogastra rugosa*, sp. n.; *a*, antenna of ♂; *b*, antenna of ♀; *c*, mandibles of ♂.

♀.—*Head*, from in front, rounded, oval, wider than deep (5 : 4), frons and vertex purplish, rather dull, reticulate, but smooth, the pattern not being raised. Clypeal edges as in the ♂.

Antennae (fig. 1, *b*) with the scape, pedicel, and ring joint, flavescent, the pedicel darker; funicle and club in decided contrast, almost black. Scape over four-and-a-half times as long as broad; pedicel less than one-third of scape, with length to breadth as 3 : 2. The first four funicular joints are longer than broad, the fifth quadrate, and the sixth broader than long. They are in the ratio 10,10, 9,9, 8,8. In the same proportion the breadth of the first five joints is 8 and that of the sixth a little over 9. The club is considerably expanded, with joints in the proportion, 5 : 4 : 5, the greatest breadth between joints one and two being 7. The sensoria are numerous, from eight on the first funicular joint, to twelve on the second club joint. There is besides a somewhat large terminal sense-organ. Length of antennae, barely ·95 mm.

Thorax with coxae and propodaeum dark metallic green, notal and pleural surfaces entirely evenly and moderately raised, reticulate.

Legs transparent yellow, with a slight tinge of brown on femora; the fifth tarsal joints and claws blackish brown.

Abdomen not triangular, but swollen, spindle-shaped, very dark and smooth, three-fourths formed by the large second and third segments. Petiole long, extending to the distal end of the trochanter.

Length, 1½ mm.; alar expanse, over 3 mm.

Host: the bean fly (*Agromyza phaseoli*, Coq.).

Described from a series of 3 ♂♂ and 2 ♀♀.

Holotype—a ♂.

Trigonogastra megacephala, sp. nov. (fig. 2).

♂.—*Head* large and broad, with wide frons and vertex, closely punctate or reticulate, gleaming or shining, and nowhere metallic. Colour almost black, with greenish tinge on the frons and purplish on occiput and vertex. The head of the single ♂ is so embedded in the fixative as to render comparative measurements of length and breadth unsafe.

Antennae (fig. 2, *a*) similar to those of *T. rugosa*, ♂, but the joints are not longer than broad, and much more sparsely haired. The antennae as a whole are rather short and dark, the scape being lighter. Scape four-and-a-half times as long as broad, pre-apically a little expanded. Pedicel, a little over one-third of the scape and hardly longer than broad. Two ring joints, the first narrower and shorter than the second. First funicular joint square, narrower than the others (4 : 5), second joint longer than broad, 3 to 6 square. The club is a little expanded, but not very appreciably, with joints in the proportion, 10 : 9 : 8. There are few sensoria; the second and third joints have one each; the fourth and fifth, two each; the sixth has four and the club joints four, two, one respectively. Length of antenna, ·65 mm.

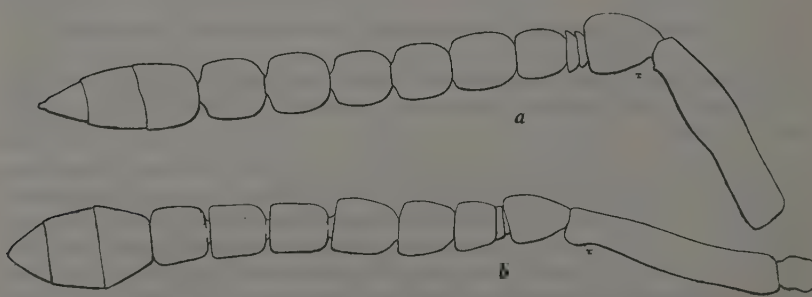


Fig. 2. *Trigonogastra megacephala*, sp. n.; *a*, antenna of ♂; *b*, antenna of ♀.

Thorax broad and depressed, with the dark purple colour of the head and the same reticulation; the pattern on the scutellum finer than in front of the suture. Metathorax gleaming, purplish blue; propodaeum entirely reticulate, dull.

Wings: not twice as long as broad (19 : 10), rather broad and somewhat bare on the basal region, evenly haired, and with one row of isoclined hairs parallel to the hind margin, at some distance above it (about one-sixth the breadth of the wing). Submarginal : marginal : post-marginal—4 : 2 : 1 ; while the post-marginal is somewhat longer than the radius (9 : 8). Length, ·95 mm. ; breadth, ·5 mm. Hind wings short, four times as long as broad. Length, ·72 mm. ; breadth, ·18 mm.

Legs entirely flavescent, except the claws and the coxae, which are black.

Abdomen short and broad, but hardly so triangular as in *rugosa* ; entirely shining, purplish black ; second segment over one-third of the whole.

Length, less than 1·5 mm. ; alar expanse, 2·4 mm.

♀.—*Head* roughened or reticulate down to the clypeal edge, which is striately marked.

Antennae (fig. 2, *b*) with the scape flavescent, six times as long as broad, not swollen near the apex. Pedicel more than a third of the scape and longer than broad (5 : 3). First funicular joint a little broader than long, and shorter than the second. Joints 2 to 5 equal and quadrate, the sixth hardly shorter and also quadrate ; club distinctly expanded, with sub-equal segments (17 : 16 : 15). The sensoria of the funicle and club are more numerous in the ♀ than in the ♂, 3, 4, 6, 6, 8, 8 ; 8, 8, 4. The pedicel of the ♂ antenna is also broader and more swollen than in the ♀. Length of antenna, ·60 mm.

In other respects the ♀ is very similar in dimensions, colour, etc., to the ♂.

Described from a single pair, ♂ and ♀. These insects were bred from a jak fruit (*Artocarpus*) which had been attacked by some undetermined insect.

Genus Closterocerus, Westw. (1833).

To this genus belong some of the most beautiful Entedonine (Omphaline) flies. The species are characterised by a fine refringent sculpture on the head and thorax, by their exceedingly brilliant metallic colour, and the maculate or banded forewings. The antennae are much flattened and the demarcation between club and funicle is hard to recognise. Westwood (Mag. Nat. Hist., p. 419, fig. 55c, 1833) in defining the genus neither mentions nor figures a ring joint. He assigns 8 joints to the genus, remarking that the last is "very minute and subulate"; apparently he ranked as a joint the terminal spur of the seventh visible segment. Girault's account (Mem. Queensld. Mus., ii, p. 177, 10th Dec. 1913) is more precise. There are seven apparent segments to the antennae, or eight reckoning the tiny ring joint which is practically concealed within a cavity of the scape. Similar flattened antennae are found in *Neochrysocharis*, Kurdj. (Revue Russe d'Ent., xii, no. 2, p. 234, fig. 3, 1912), but the wings in this genus are hyaline.

The genus *Closterocerus*, Westw., is at present a small one. Schmiedeknecht (Gen. Ins. Wytsman, p. 428, 1909) lists 11 species, and one or two have since been described from North America, Java and Australia. Kurdjumov (*loc. cit.*, p. 235) points out that besides *formosus*, Westw., and *trifasciatus*, Westw., *Entedon ovulorum*, Ratz., should be placed here. There are therefore at least three European forms. Crawford (Proc. U.S. Nat. Mus., xliii, p. 175, 1913) mentions five species (one doubtfully) as

occurring in the States. From the West Indies are recorded *C. albipes*, Ashm. (Journ. Linn. Soc. Lond. Zool., xxv, p. 177, 1894), *C. auriceps*, Ashm. (*l.c.*), *C. leucopus*, Ashm. (*l.c.*) and Schmiedeknecht adds *C.* (*Derostenus*) *rotundus*, Ashm. (*l.c.*, p. 174).

From an examination of the types or co-types of these West Indian species, I have doubts whether any should be included in Westwood's genus. On the other hand *Necremnus purpureus*, Howard (Journ. Linn. Soc. Lond. Zool., xxvi, p. 164, 1896), is, so far as one can judge, a true and very distinct species of *Closterocerus*. Unfortunately, the unique type is headless.

Two South American forms have also been included here, viz., *Entedon xenodice*, Walk. (Ann. Mag. Nat. Hist., x, p. 273, 1843) and *E. pelor*, Walk. (Ann. Mag. Nat. Hist., xi, p. 185, 1843), both Chilian species, with long-fringed and slightly clouded wings. The propodaeum of these insects, however, has two delicate divergent central keels and the structure of the thorax appears to be different from that of *Closterocerus*.

Two examples of a *Closterocerus* apparently new and conspecific are included in Mr. Rutherford's gatherings. Neither is, unfortunately, in very good condition, but it has been possible to draw up a fairly complete account from one or other of the specimens of the species described below.

C. insignis, sp. nov., comes very near to the genotype *C. trifasciatus*, Westw., but differs in size, being only two-thirds as long. In *C. trifasciatus* the metanotum is concolorous with the scutellum and distinctly, though finely, punctate. In *C. insignis* the metanotum is concolorous with the propodaeum, shining and appearing as a gleaming edge to the scutellum. In the new form also the mid tibiae seem lighter in colour and the fringe to the fore wings relatively longer. The antennae also show important differences, those of *C. insignis* being relatively broader and flatter, with the first three funicular joints sub-equal and the fourth hardly narrower than the third; while in *C. trifasciatus* the second funicular joint is distinctly greatest, the fourth diminishing rather suddenly as compared with the third. In *C. insignis* the ring joint is extremely minute (·025 mm. broad; distinctly visible only under obj. $\frac{1}{12}$ × ocular iii, Zeiss), and the edge is barely above the rim of the pocket in the pedicel in which it is accommodated.

The species may be shortly diagnosed as of moderate size, the head and thorax brilliant dark green, the parapsides bluer, the remainder of the body dark purple violaceous. Wings trifasciate, the basal band indistinct, the median broad, and the terminal narrow. Marginal vein very long. All the hind legs, except the last three tarsal joints, dark.

Closterocerus insignis, sp. nov. (fig. 3).

♀.—*Head* very wide and narrow on the vertex. Eyes quite bare, occiput reticulate, brilliant blue-green, rather dark; vertex and frons (fig. 3, *c*) to level of scrobes reticulate, rich dark blue in colour near eye margins, with a greenish lustre round the smooth ocellar triangle; scrobes oval, with a longitudinally striated triangular sclerite bearing two bristles between. Above the mouth the violet-coloured clypeus is so faintly reticulate as to be practically smooth. Mandibles (fig. 3, *b*) bidentate* and of normal shape; inner tooth larger, its inner edge once slightly

* Girault describes the Australian forms as tridentate.

sinuated; three longer bristles near the outer edge, and one or two near the apex; outer edge rather deeply concave near the broad base. As in *Chrysocharis*, the palpi (maxillary and labial) bear one stout apical bristle and another nearer the base, one bristle between the labial palpi, and one behind the maxillary palpus near the edge.

Antennae (fig. 3, *a*) remarkably compressed, with seven apparent joints, in reality eight, the ring joint concealed. Scape triangular, expanded distally, two-and-a-half times as long as broad, and almost equal to the pedicel and first three funicular joints. All the bristles of the antennae are stout, and in particular the pair at the upper distal

Fig. 3. *Closterocerus insignis*, sp. n., ♀; *a*, antenna; *a.*, concealed ring joint; *b*, mandible; *c*, frons; *d*, wing; *e*, hairs inside base of radius; *f*, hairs from darker band; *g*, hyaline hair from clear area; *h*, hair from under surface of dark band; *i*, hind tarsus; *j*, antenna of *Closterocerus trifasciatus*, Westw., ♀.

angle of the scape are almost spine-like. On its upper half the scape is moderately thick, but below this it is drawn out into a long edge. Pedicel as long as broad, with convex sides; no sensoria. No definite club, all the funicular joints, save the last, broader than long, considerably flattened, with sharp edges; only simple, strong bristles and narrow, oval or more elongate sensoria present; last joint pear-shaped, with long terminal style.

Thorax considerably depressed, coloured like occiput, but bluer at the sides. Mid-lobe of mesonotum and the scutellum broad. The parapsides and axillae narrower than usual; the axillae wide apart and only a little entering the parapsides. Entire tegument of thorax heavily chitinised and so densely reticulate as to appear punctate, except under a high power. The usual pair of Entedonine bristles on the scutellum; tip of scutellum narrowly shining. Mesophragma short, descending almost vertically and not directed backwards; mesoprepectus very large; the pleurae coarsely reticulate. Metathorax and propodaeum narrow, together only half as long as broad, the former almost linear; no postero-lateral horns or processes to propodaeum. Notal surface coarsely reticulate at sides, with lateral folds, but no median carinae present. Propodaeum deeply incised (up to half) for the reception of the first abdominal segment. Spiracle narrow, oval, small, opening at the outer anterior angle of the lateral fold.

Abdomen rounded, oval. Segments subequal; on each there is a posterior row of bristles—medianly incomplete on segments 1 to 3—with one or two others in front at the sides. Surface of abdomen slightly reticulate medianly from seg. 3 to seg. 5. The saw bears terminally about half-a-dozen teeth and the free portion of the sheath is one-sixth of the whole. Metathorax, propodaeum and abdomen dark violaceous or purple, with lighter reflections on the disc of the abdomen.

Wings: Fore wing (fig. 3, *d*) with the marginal longer than the submarginal (2:1); post-marginal and radius subequal. Whole wing broadened apically; length to breadth, 2 : 1. Bristles on marginal veins strong, from the post-marginal to the lower angle the fringe is long. Radial vein thick and spatulate, with four cells rising near the middle. The surface of the wing is covered with hairs of unequal calibre (fig. 3, *e–h*); next the distal edge is a band 3–6 rows deep of thicker, short bristles, almost black in colour; a similar belt, half as broad again, stretches across the wing at the end of the marginal vein, and another, less definite, nearer the base of the wing; between these belts there are weak hyaline hairs; the clear band parallel to the hind margin is somewhat broad. All the veins dark; a small dark patch below the end of the marginal vein; the wing also is dark wherever the heavier bristles are disposed, and hence its characteristically banded appearance. Length, ·9 mm.; breadth, ·45 mm. Hind wings hyaline, unclouded, with long fringe. Length, ·75 mm.; breadth, ·2 mm.

Legs with all coxae and femora, hind trochanter, hind tibia and first hind tarsal joint black; fore and mid trochanters smoky; fore and mid tibiae, with their tarsi, and last three hind tarsal joints (fig. 3, *i*) pale, the fore tibiae being a little smoky, especially near the base. The proportions of the tarsal joints are remarkable, being practically the same in all the legs, both absolutely and relatively.

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.
Fore	13	14	14	38
Mid	15	15	15	40
Hind	14	15	16	40

The preapical tibial spur of the fore legs short and weak; the spur of the second tibia long and saltatorial, reaching to the middle of the second tarsal joint; the subapical femoral spurs of the same leg strong; the tibial spur of third leg strong and short, with a comb of seven short spines on inner aspect.

Length, 1·25 mm.; alar expanse, nearly 2·5 mm.

Described from a single female, bred 3., viii., 1914.

Host: the tea fly (*Oscinis theae*).

Genus Sympiesis, Först.

The following species is apparently congeneric with *Sympiesis felti*, Crawford, (Proc. U.S. Nat. Mus., xl. p. 448, 1911), described from *Agromyza melanopyga* in fern leaves. In the single ♂ present in the material the frons had been injured and the antennae crushed off at the scape. Two chitinous fragments adhering to the face were detached, and after treating with potash followed by glacial acetic acid, were sufficiently swollen to be identified as the first and second funicular joints; neither was furnished with a branch or unusually long hair. All the generic characters are, I think, distinctly marked, except in the condition of the hind tibia, which unless carefully examined, might be taken as indicating a Hemitarsenine affinity. The second spur, however, though short, is undoubtedly present. *Sympiesis purpureus* is a purplish black form, with duller thorax and entirely dark antennae. The abdomen shows bluer reflections. The legs are pale, with darker tarsal tips and femoral streaks.

Sympiesis purpureus, sp. nov. (fig. 4).

♀.—*Head* much broader than deep (4:3), eyes bare, swollen and prominent. Vertex, frons and clypeus shining, without pattern (except within the ocellar triangle); scrobes roughly circular, or square with rounded angles; a narrow linear ridge between the mouth corner and the lower eye angle; clypeal edge simple, concave. Occiput reticulate, with a few short bristles. At each side of the vertex two bristles; posterior ocelli wide apart near the occipital edge, with four bristles between and one in front of each; along the orbits about 10 minute bristles. Frons remarkably bare. Before the narrow ridge separating the face from the genae are two minute bristles, and four more stand in a square above the middle of the mouth edge. Although the surface of the face is uniformly smooth, there is an internal reticulation of the integument demonstrable by focussing through. Behind the malar keel there is a distinct, curved, elongate reticulation, and the usual row of post-ocular bristles.

Antennae (fig. 4, *a*) with scape, pedicel, ring joints, four funicular, and two club joints. Scape long and narrow (5:1); pedicel transverse, hardly wider than the scape and extremely short (one-fifth of the scape or one-half the first funicular joint), with a reticulation so coarse that one cell extends almost the length of the joint; ring joints (two) minute, narrow, closely appressed. Joints of funicle equal, the first distinctly, the second almost, cylindrical; joints 3 and 4 appear slightly shorter, as their distal angles are rounded off and the joint produced into a neck. Club not expanded, one-and-a-half times as long as the joint of the funicle; basal joint a little longer than the apical one, which has a short, blunt spur. The whole antennae bristly and the flanges of the sensoria stout. Length of antenna, ·65 mm.

Mouth-parts (fig. 4, *b, c*): cardo shaped like a jack-boot, stipes rather narrow; maxillary palpus two-jointed (2:3), the first joint broader and bare, the second slightly tapered, with one bristle near base, three more distally and a long terminal one with a minute bristle at the side. Mentum rather broad, reticulate like the stipes. Labial palpus just exceeding basal joint of maxillary palpus, ending truncately with two long bristles and a minute one between. The lingua with six setigerous marginal cells. Mandibles somewhat oblong, with an outer (ventral) strong tooth separated by a deep incision from an inner one which is somewhat longer. The apical inner (upper) edge of the mandible is serrate with three to four denticles. Posteriorly the inner edge is strongly angled at one-half and swollen again basally. In both ♀ ♀ examined the denticles on the left mandible are more strongly developed.

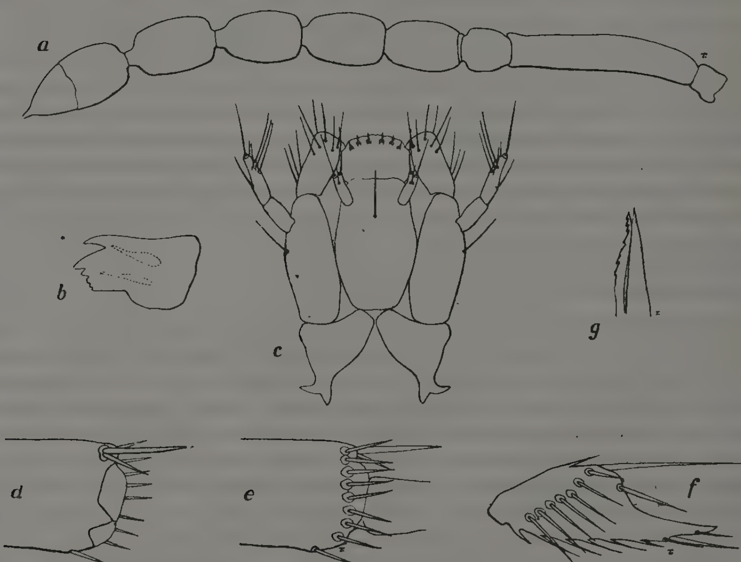


Fig. 4. *Sympiesis purpureus*, sp. n., ♀; *a*, antenna; *b*, mandible; *c*, trophi; *d*, apex of hind tibia (front view); *e*, the same (from behind); *f*, first joint of fore tarsus (front view); *g*, apex of ovipositor.

Thorax: prothorax coarsely reticulate, save for a rather broad median area where the pattern is fine and transversely drawn out. There is a small postero-lateral semi-circular excision for the spiracle. On each side of the bare median area posteriorly are three strong bristles, with three to four weaker ones in front, besides one or two microscopic bristles; on the anterior edge are two median bristles. Mesonotum with generally equal, moderate, clearly raised reticulation, which is just a little coarser posteriorly. Parapsidal furrows merely indicated anteriorly. The bare axillae penetrate deeply and their pattern is rather drawn out and not raised. One bristle opposite the inner anterior angle of the axillae, another in front, between

the apex of the axillae and the end of the furrow, and a third behind the edge of the prothorax near the middle. Scutellum with two bristles on each side, both beyond one-half; pattern finer than on the mesonotum, drawn out and hardly raised. Mesopleurae reticulate; mesoprepectus large, with coarse raised pattern; metanotum medianly reticulate, with smooth side areas; propodaeum smooth, with well-developed keel. Spiracles nearly circular, "metapleurae" with a fringe of six to seven silky hairs on lowest edge above the ridge.

Wings: fore wings having the submarginal cell well developed, with a dozen hairs. Submarginal vein with nine to ten bristles; the portion of the marginal vein which bounds the submarginal cell bears five to six bristles, and on the rest are numerous dense short bristles. The radius is short, with a narrow neck and quadrate end; four cells; post-marginal twice the radius; marginal ciliation short. Submarginal : marginal : radius : post-marginal, as 5 : 10 : 1 : 2. Behind the marginal vein is a narrow clear strip with one row of twelve bristles; from the junction of the marginal and submarginal veins a row of six slopes towards the posterior edge, bounding the clear area referred to. Parallel with the hind margin runs a row of isoclined hairs, from which, above the middle of the frenulum, a double row of similar hairs, bounding a very narrow and not well-defined line, goes to the middle of the distal edge of the wing. The rest of the wing, except the basal triangle, is evenly haired. Length, 1·1 mm.; breadth, ·55 mm. Hind wings: length, ·9 mm.; breadth, ·20 mm.

Legs: all the coxae blackish, all the fourth tarsal joints dusky and blackish at the tips, the remaining joints of the tarsi and the tibiae pale; the femora are mainly pale medianly, with a blackish streak on the upper and lower edges in the fore and hind legs, more extensive in the femur; in the mid legs the black femoral streak is developed almost entirely on the ventral edge. *Fore legs*: coxae coarsely reticulate outside near base, apical bristle rather long, six to eight minute pre-apical hairs. Femur not swollen, somewhat bare, with only three to four hairs in the ventral row, all on basal half; the pre-apical postero-ventral bristle is long; there are five to six hairs on the upper edge, and on the posterior face a median row of eight to ten bristles, and four to five shorter ones below the apical edge; on the anterior face are over a dozen short bristles disposed in two irregular rows along the upper edge, the two subapical and median ones being stronger. Tibiae with eight to nine bristles on the upper edge, and numerous weak short bristles on the ventral aspect, mainly towards the apex; two anterior stouter bristles; the apical ventral bristle is single. First tarsal joint with a distinct comb of six even parallel short spines on the anterior aspect. *Mid legs*: the coxa bears a patch of five clear short spines on the inside. Femur with a submedian posterior row of five bristles, beginning at one-third from the base to near the apex; subapical bristle dark and strong, spine-like. *Hind legs*: femur with eight to nine bristles on anterior aspect ventrally, but some distance above the edge; another row (six to seven) just above the middle line, mainly on the apical half; between this row and the edge there are about half-a-dozen shorter bristles; on the posterior surface are several scattered bristles, of which about six (rather longer) form a median row. Tibia with one long and one short stout apical spine, and besides a transverse comb of about eight spines.

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.
Fore	15	20	20	40
Mid	20	28	24	36
Hind	20	30	20	40

Abdomen with all segments subequal; 2 and 3 shorter, 4 to 7 a little longer. The middle of the dorsum smooth, while the tergites are reticulate on the overlapping flaps. Spiracle small and round. The eighth tergite is very bristly; the stylet short, conical, with five bristles (one long). Free portion of sheath, which is broad, oval, pointed, with about 20 shorter bristles, one-fifth of the base. The saw is pale, with a black apex and seven distinct teeth; three are at the apex, then after a deep notch follow three more, with a seventh, rather fainter.

Length, over $1\frac{1}{2}$ mm.; alar expanse, about 3 mm.

Host: a microlepidopterous leaf-miner (*Acrocercops ordinatella*, Meyr.) of the camphor plant.

Described from 1 ♂ and 4 ♀♀.

Holotype—a ♀

Genus Syntomosphyrum, Förster.

Perhaps the most interesting of Mr. Rutherford's captures is a Tetrastichine species represented by three ♀♀ assignable apparently to the above genus. All three examples were bred from a Coccinellid pupa, two being robust and of equal size, while the third is considerably smaller.

I have elsewhere (p. 364) given my reasons for restricting the name *Syntomosphyrum* to Tetrastichines with an unlined mid lobe on the mesothorax, while the scutellum is furrowed only between the dorsal and lateral aspects. In the present case the apex of the mid lobe shews a minute median excision at the suture, the mid line of the lobe being, if anything, paler, and apparently a little depressed posteriorly, though no real impressed line or furrow can be traced. After potash, the scutellum exhibits two extremely fine and incomplete parallel longitudinal lines inside the lateral sulci. In thoracic characters, then, *S. taprobanes* occupies a transitional position between *Syntomosphyrum*, *Tetrastichodes* and *Tetrastichus*. The concomitant antennal characters are also somewhat variable, e.g., the ring joints and the number of funicular joints. Therefore without questioning their practical utility, I think it likely that the above genera constitute a graded series with no very natural division. I have placed the Ceylonese form in *Syntomosphyrum* mainly because of its evident affinity with the species Silvestri has described under the name *S. indicum* (Boll. Lab. Zool. Agr. Portici, iv, p. 232–344, fig. iii–viii, 1910). The two indeed come close, but there are minute differences all over, which induce me to treat them separately at present. Of these differences, some of which are tabulated below, the most easily recognised lie in the antennae and hind tarsi. The species

also appear to be quite different in habit. The ♀ ♀ of *S. taprobanes* probably seek and sting their prey in the normal manner. Silvestri (Report of an Expedition to Africa in search of the natural enemies of Fruit Flies (Trypaneidae); Territory of Hawaii, Board of Agriculture and Forestry, Bull. No. 3, Div. of Entomology, p. 126, 11th Feb. 1914) describes how the ♀ ♀ of *S. indicum*, having found a fruit with broken rind, carefully test with their antennae for their prey, in pursuit of which, when located, they plunge into the decaying pulp and entirely disappear from view. Eventually the larva is overtaken in spite of its strenous efforts to escape, and oviposition takes place.

Syntomosphyrum taprobanes, sp. nov. (fig. 5).

Head broader than deep (4:3), entirely shining black. After potash, the integument shows a finely reticulated pattern, but the space above the mouth is almost smooth. Clypeal edge bilobed; scrobes not far apart, oblong oval, set plainly above the base line of the eyes; a well defined keel from the corner of the mouth to the inner lower angle of the eye; malar space three-quarters the depth of the eye. Three short stiff bristles on orbits at vertex, two between orbits and middle of occiput, six (?) on the ocellar triangle, with a few shorter ones on vertex behind the triangle and on the top of the occiput below. No occipital ridge or sharp edge. At the top of each frontal sclerite, above or near the apex of the scape, about eight minute bristles and nearly a dozen below to the level of the scrobes; also about a dozen between each scrobe and the malar keel, three minute bristles on each clypeal lobe, and one or two more between the mouth edge and the base of the scrobes.

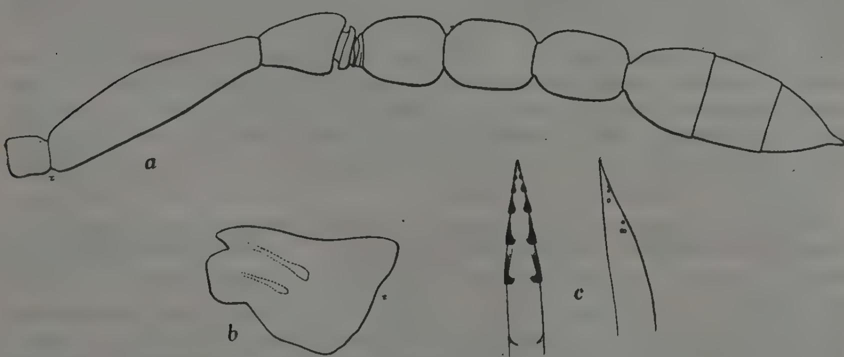


Fig. 5. *Syntomosphyrum taprobanes*, sp. n., ♀; *a*, antenna; *b*, mandible; *c*, apex of ovipositor.

Antennae (fig. 5, *a*) 10-jointed; scape, pedicel, two ring joints, three funicular, and three in club; entirely dark blackish brown. Scape four times as long as broad; pedicel one-third the length of the scape; the first ring joint more robust and brownish, the second hyaline and bilaminate. Joints of funicle increasing in ratio

8:9:10, the first as wide as long, the next two longer than wide; the joints bear from six to ten or more sensoria. Club joints practically equal in length (15:15:14), but the second is broadest, while the third is suddenly tapered; terminal hair of spur short and fine, not more than a quarter of the third club joint; club as a whole definitely wider than the funicle. Length of antenna, ·75 mm.

Mouth-parts: mandibles (fig. 5, *b*), outer (ventral) edge gently concave towards the base, bidentate; outer tooth smaller, separated by a sharp but not deep notch from the inner, which is broad, with straight, truncated apex projecting a little beyond the outer tooth. Inner edge of the second tooth slightly swollen, as is also the basal two-thirds of the inner edge, which as a whole is concave at the base of the second tooth. Maxillary palpus two and a half times as long as the labial palpus; cardo with two bristles, one larger lateral, the other opposite the base of the palpus. Two (?) short bristles just behind the base of the palpi on the mentum; four short bristles from single cells in the lingua. The labrum bears anteriorly two strong median and two weaker lateral bristles (1, 2. 1.)

Thorax: prothorax semicircularly emarginate at the spiracle, with bare triangular area (whose base occupies the median one-third of the posterior margin) flanked on either side by about ten microscopic bristles; posterior row of bristles 3,3, and one additional, stronger at the spiracle; the whole surface evenly and moderately reticulate. Mesothorax with the parapsidal furrows straight, except for a slight outward bend anteriorly; mid lobe black, gleaming, surface covered by an extremely fine (especially medianly) drawn out reticulation; on the inside of each furrow are three bristles; parapsides invaded very deeply (to beyond one-half anteriorly from the suture), with two bristles; at the middle of the suture the mid lobe is narrowly depressed for a short distance forward, but no definite furrow is formed. Scutellum square, with two strong lateral furrows and two faint impressed lines inside; reticulation similar to that of mid lobe. Mesosternum distinctly, and mesopleurae rather faintly reticulate; mesoprepectus narrow and wedge-shaped. Metathorax with the middle area rather narrow, reticulate; side areas smooth, with one or two irregular rugae. Propodaeum with a short central keel, deeply emarginate (to one-half) posteriorly, reticulate, hardly raised; spiracle large, oval, with a longish bristle outside and two shorter in line posteriorly.

Wings: fore wings with the veins stout and black, marginal ciliation moderate; submarginal cell narrow, with about a dozen bristles. Submarginal vein with two bristles; marginal vein with less than a dozen larger fringing bristles, and many others shorter; radius thick, slightly expanded towards the apex, concavely truncate, four cells and six bristles. Submarginal; marginal: radius, as 10 : 15 : 4. Length, 1·45; breadth, ·65 mm. Hind wings with the veins thick; submarginal: marginal, as 5 : 6. Length, 1·1 mm.; breadth, ·25 mm.

Legs: not densely clothed; all the coxae, trochanters and femora (except indistinctly near the apex) blackish; the tibiae fuscous, almost black; the tarsal joints concolorous with the tibiae, those of the mid legs somewhat paler. Fore legs with the ventral fringing hairs short and weak, pre-apical bristle inconspicous; tibia with single short stout apical spine, and a row of about ten short bristles on outer aspect; across the apex a comb of four spines; first tarsal joint with, on the inside, a longitudinal comb of six short stiff bristles. Mid legs with the femora almost

bare ventrally; tibia with apical comb of four spines and spur as long as first tarsal joint. Hind tibia with apical comb of from seven to eight spines and spur shorter than the first tarsal joint.

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.
Fore	17	30	30	40
Mid	22	35	32	45
Hind	25	38	35	45

Abdomen rather broad and short, shining black; the tergites faintly reticulate medianly, but distinctly so at the sides and on the portion underlapping the sternites; petiole short; tergites 2 and 5 subequal. Post-median row of bristles interrupted in the middle on tergites 2 and 3. Spiracle small and circular. The stylet on tergite 8 very short, bearing four longish equal bristles; at least twenty bristles in front and eight to nine behind the stylets; there are besides six to eight longer bristles on the ventral edge, overlapping the upper sheath of the ovipositor (tergite 9). Ovipositor with the side-pieces (from sternite 8) expanded distally and ending in a somewhat long acute point. They do not share in the serration of the saw proper, which bears three to four extremely minute apical teeth and three much stouter behind; these serrations extend only over the apical one-eighth of the saw (fig. 5, *c*) which is .4 mm. long and stout basally. The sheath (ninth tergite) is rather longer than the saw, and the distal articulated portion is two-ninths of the whole; each free lobe bears four bristles and there are two others on the apex of the fixed portion of the tergite.

Length 1½ mm.; alar expanse, over 3¼ mm.

Host: a Coccinellid beetle (*Scymnus* sp.)

Described from a ♀ bred from the pupa of a *Scymnus*, 20. ii. 14.

The following statement sets forth the characters which distinguish this new species from *S. indicum*, Silv.

Syntomosphyrum indicum, Silv.	**Syntomosphyrum taprobanes**, sp. n.
Head.	
1. Two-thirds of scrobes below base line of eyes.	1. Scrobes clearly above base line of eyes.
2. Frons behind scape with only a few bristles (8 to 10).	2. Frons behind scape with many short bristles (20 to 24).
3. Inner mandibular tooth with apex concave.	3. Inner mandibular tooth with flat, broad apex.
4. Median hairs on mentum well behind labial palpi.	4. Median hairs just behind labial palpi.
5. Antennae castaneous; pedicel just less than half the scape. Joints of funicle transverse; third joint distinctly broader than long; first joint with two sensoria; bristle to spur of club as long as, or longer than, the last club joint.	5. Antennae black; pedicel one-third of scape. Joints of funicle never broader than long, gradually increasing; joints 2 and 3 cylindrical; first joint with six to seven sensoria; bristle to spur of club very short, one-quarter of last club joint.

Thorax.

6. Two bristles and a clear spot (non-setigerous) inside furrows.	6. Three bristles along inside of parapsidal furrows.
7. Keel of propodaeum continued through middle of the metathorax.	7. Metathorax not carinate.

Abdomen.

8. Second segment longer than third.	8. Second segment subequal to third.
9. Total length of ovipositor, ·26 mm.; apical one-third serrate.	9. Total length of ovipositor, ·4 mm.; apical one-sixth serrate.

Legs.

10. Hind tarsi with joints 1 and 3 subequal, 2 longer.	10. Hind tarsi with joint 1 shorter than 2, which is equal to 3.

Genus TETRASTICHODES, Ashm.

The following species is separated from *Syntomosphyrum*, Först., mainly by the well-marked though fine furrow on the scutellum. The legs of this insect are unusually bristly and the first mid tarsal joint long.

Tetrastichodes asthenogmus, sp. nov. (fig. 6).

Head a little broader than deep. Eyes seen from in front rather narrow and wide apart, the intervening space over twice the visible diameter of the eye. Mouth edge straight, transverse, with two inconspicuous central lobes. Scrobes oval, their lower edge just on the base line of the eyes. Vertex rather narrow, suture high up, so that the anterior ocellus lies within the wide angle formed by the frontal plates; suture between the plates disappearing at the scrobes, between which there is no median plate; a distinct keel from the clypeal corners to the lower edge of the eye. On the occiput are numerous short erect hairs; on the vertex medianly behind the

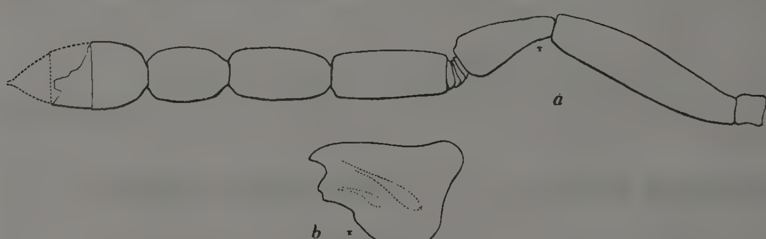


Fig. 6. *Tetrastichodes asthenogmus*, sp. n., ♀; *a*, antenna; *b*, mandible.

ocelli two short spinose hairs, and a similar pair on each side near the eye margin; from the anterior ocellus to the scrobes is a rather wide, practically bare median area; half-way to the orbits is an irregular row of minute bristles (8–10), and a similar row on the orbits themselves; between the scrobes is a double row (4, 4) of short stiff bristles, and from this level to the mouth edge are numerous (60–70) minute bristles.

Antennae (fig. 6, *a*) in both specimens imperfect, but probably with the following joints: scape, pedicel, ring joints, three funicular and three (?) to the club. The scape and pedicel are lemon-yellow in colour, the others fuscous. Scape with

numerous short bristles outside and 10–11 on dorsal and ventral edges; six times as long as broad. Pedicel one-~~third~~ of the scape, narrow, over twice as long as broad. half Four laminae—representing two or possibly three joints—intervene between pedicel and funicle. Funicular joints cylindrical, decreasing in length and almost exactly in the ratio 5:4:3, but of equal breadth, the first joint being about $2\frac{1}{2}$ times as long as broad. Club 3-jointed (?), not expanded; the first joint slightly shorter than the last joint of the funicle; funicle and club very bristly.

Mouth-parts: mandibles (fig. 6, *b*) broad basally, with three teeth, of which the outer is large, separated by a semi-circular sinus from the inner pair, which are minute. Inner edge of mandible at first straight then much swollen towards the base. Cardo produced posteriorly into a hook, stipes with two hairs at side. Maxillary palpus long, with one outer hair at one-half and three at the apex. Labial palpus hardly more than a quarter of the maxillary and with similar hairs, those at the apex very long ($2\frac{1}{2}$ times as long as the palpus itself). The usual bristle on the mentum is placed far back and not nearly between the base of the palpi.

Wings: fore wings over twice as long as broad, long and narrow, evenly ciliated, fringe short. Submarginal : marginal : radius, as 3:5:1; submarginal with 4 bristles, marginal with 13; radius club slender, with 4 cells. Length, 1·3 mm., breadth, ·57. Hind wings about three times as long as broad. Submarginal : marginal, as 2:3. Length, 1·1 mm.; breadth, ·27 mm.

Thorax: prothorax moderately broad, considerably sinuated above the spiracle on the posterior edge, coarsely reticulate all over, smooth, with many short bristles (40–45) on each side of a narrow smooth depressed area, and a posterior or marginal row of twelve stronger bristles. The prosternum is a truncate square with two short hairs before the posterior edge.

Mesonotum considerably longer than broad. Parapsidal furrows widely apart, deep; parapsides deeply invaded by axillae. Mid lobe with 25–30 short hairs, of which a pair at the sides of the apex are stronger; parapsides with about a dozen hairs; axillae bare. Scutellum oblong quadrate, with two widely separated deep lateral sulci meeting the suture outside the ends of the parapsidal furrows and concurrent with the inner edge of the axillae. There are also two faint impressed lines forming a square with the anterior and posterior edge of the scutellum. The end of the parapsidal furrow bisects the distance between the lateral and the faint inner scutellar furrows; from the middle of the suture two narrow lines go to the posterior ends of the faint lateral furrows. The square mid lobe of the scutellum is bare; on the narrow lateral lobes are, on each side, a strong and a weaker short bristle, and a curious minute knob on the suture. The reticulation of the mesothorax is comparatively even, all the cells being drawn out and pointed; anteriorly the parapsides are coarsest. On the mid lobe the surface *inside* the cells is a little raised. The scutellum, though densely reticulate like the rest of the mesothorax, is comparatively smooth, the pattern on the lateral lobes being extremely finely drawn out. The mesophragma is as long as the scutellum; mesopleurae, with furrow, entirely smooth; mesoprepectus with coarse striate reticulation, except along the anterior edge, with two minute hairs at ventral angle; mesosternum smooth, but with faint reticulation posteriorly, nearly bare, save for one or two minute hairs on each side near hind edge.

Metanotum smooth, side areas each with a short hair; the middle area slightly swollen and (after potash) exhibiting a trace of reticulation at the sides. Propodaeum more than twice as broad as long, sides nearly parallel; edge between pleura and sternum defined, smooth and very flat; central keel short and not distinct. Spiracle oval, as far from the centre as the length of the segment. Below the spiracle are three hairs on the metapleurae. Posterior edge of the propodaeum considerably excavated in the middle to receive the abdomen.

Abdomen sessile, brown, slightly shining, petiole minute, tergites subequal in length, medianly smooth and faintly reticulate on the overlapping sides; spiracles small, nearly circular. Each tergite bears a posterior row of short hairs (incomplete near the sides on tergite 1); in front of the row at the sides are one or two irregular short hairs, and from tergite 2 onwards there is a more or less continuous post-median row; on each side of the mid line on all the tergites one of the hairs is the longest in its row.

Legs conspicuous for their length, the difference being in the posterior pairs of tibiae. All the legs and the posterior coxae pale yellowish; the anterior and mid coxae dark, and the anterior femora a little infuscated. Anterior coxae large, a little swollen. In both fore and mid legs the preapical subventral bristle is long and stronger than the hairs of the ventral row. The tibiae are densely clothed with hairs or short bristles. The hind and mid tibiae are to the corresponding femora as 5 : 4. First joint of fore tarsi flattened slightly.

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.
Fore	30	35	28	35
Mid	55	43	28	35
Hind	60	50	30	45

Length, $1\frac{1}{2}$ mm.; alar expanse, 3 mm.

Described from two ♀♀ taken on the egg-capsule of a cockroach, 7.i.14.

NOTES ON AFRICAN CHALCIDOIDEA—II.

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Family EULOPHIDAE.

Genus Pleurotropis, Förster.

In the confusion existing as to the meaning of the various Entedonine genera, I think it best to define the sense in which *Pleurotropis* is employed in the following pages. The essential character of the genus is, I take it, the presence on the smooth propodaeum of two central keels, which diverge apically to meet the raised posterior edge of the segment. There are also present two lateral keels, as a rule strongly developed, running (*inside* the oval raised spiracle) along the edge from which the descent to the pleura begins. The lateral keels join the posterior edge above a generally slightly protruding angle inside the insertion of the metacoxae. The general shape of the propodaeum is transversely quadrate, not truncately triangular as in *Entedon*. The petiole, which joins the propodaeum by a distinct, though often very short, process, is pitted, quadrate or even sub-pentagonal in section. The proportion of the first abdominal tergal surface to the whole visible surface varies sexually and specifically from less than one-third to three-quarters.

The scutellum shows the usual Entedonine bristles. The parapsidal furrows vary in distinctness in different species, but can, I think, always be traced by altering the position and illumination of the specimen under examination. They seem invariably to bend rather abruptly at about the middle of the mid lobe, which bears apically at the sides a distinctive seta. The area round the seta may be depressed or smooth, or different in sculpture from the rest of the mid lobe.

The head is generally broad, and the eyes are bare, pubescent, or completely hairy. The antennae in both sexes have nearly always eight joints: scape, pedicel, ring joint, three in the funicle and two in the club, with the terminal spur not articulated. In the female the funicle and first club joints are generally more cylindrical and increasingly stouter; in the male they are more bead-like and of equal breadth. The ring joint is very small, but highly magnified (600–1,000) shows a complex laminate structure. Proximally there is the usual short stalk of insertion with the pedicel, and the dorsal edge is solid and chitinised. When the antenna bends upwards the ring joint is seen to consist of two to three laminae, which are distinctly separated only ventrally.

Förster (Hym. Stud., ii, p. 78, 1856) includes *Pleurotropis* with *Entedon* amongst the genera with less than twelve joints in the antennae, and further remarks (*op. cit.* p. 82): "Die Fühler sind in beide Gattüngen achtgliedrig, oder wenn man den griffel an der spitze des letzen Gliedes mitzählen will, neungliedrig, beim ♀ mit zwei ringeligem, beim ♂, mit nicht geringelten Endglied."

According to Ashmead (Mem. Carn. Mus., i, pp. 341, 342, 1904) there are ten joints in the antennae: "Scape, pedicel, ring joint, four funicular, and three in the club." In this reckoning, the "Endgriffel," or spur, is counted as a joint, but in the African

species I have personally examined, this equivalence cannot be maintained. But even allowing for this, there is still a discrepancy between the number of joints given by Ashmead and Förster respectively. Ashmead was evidently acquainted with species, reckoned by him as *Pleurotropis*, Först., which possess a four-jointed funicle, and Crawford (Bull. U.S. Dept. Agric., Tech. Ser. no. 19, pt. ii, 1910) suggests that one such form, *P. atamiensis*, Ashmead, is probably an undescribed genus. In the paper just quoted Crawford states that in several Japanese species the ♀♀ have a three-jointed funicle, and presumably the American species to which he has supplied a key (Proc. U.S. Nat. Mus., xliii, p. 177, 1913) answer to this description. In any case *P. telenomi*, Crawford (Proc. U.S. Nat. Mus., xl., p. 445, 1911), from Uganda, has three funicular joints and otherwise agrees with the sense in which *Pleurotropis* is here employed.

The fore wing of the genus is remarkable for the great development of the marginal vein which is sometimes over twice as long as the submarginal. The tiny bristles on the clypeus have evidently considerable value for the taxonomist, but they are hard to observe and seldom well preserved. I have discussed them only in describing *P. neavei*, sp. n. Generally the malar space is large and triangular, but it may be much reduced. The mouth-parts of *Pleurotropis* are of great importance. While the trophi are of the usual Entedonine type (see under *P. neavei*), the mandibles exhibit much diversity. They may be bidentate, with equal or unequal teeth, and more or less deeply cleft. The inner apical edge of the inner tooth may be straight, swollen, or minutely serrate. Probably the most natural characters for the separation of the genus into species, or at any rate, groups of closely allied species, are to be found here. Fundamental as these slight differences appear to be, I have not based the following short key on mandibular characters, chiefly because material for dissection has not been available in the case of all the species

The scutellum and propodaeum also afford most important characters. In the former, differences of sculpture and pattern can be easily expressed, but I have found it almost impossible to put into words the moulding of the propodaeum. Mr. Terzi's skilful drawings give an adequate representation of this region in the species now described. In the discussion of various surface levels and light values between author and artist recourse to modelling in plasticine has had satisfactory results. On the notum of the propodaeum the chief points to be attended to are the curvature of the median keels, their distance apart and the nature of the hollows before the stalk, *e.g.*, whether single or multiple, shining or dull; and in the latter case, whether smooth or pitted. On the pleura the position and size of the stigma are of value.

The chief variation of the propodaeum in any species seems to occur inside the central keels, where false or incomplete keels are frequently thrown up. The distal hollows are much more constant.

In the case of the wings, antennae, and leg joints, the measurements have been taken from balsam mounts. Those of the visible segments of the abdomen, the total length of each species, and its alar expanse are more approximate, being taken from card-mounted specimens, by slipping a micrometer on to the diaphragm of the eyepiece (no. iii., with objective a_3) of a binocular dissecting microscope. For detailed descriptions, the same objective, with eyepiece no. v. has been used. The

measurements of tarsal joints have been taken along the dorsal edge, and the fourth joint reckoned as extending to about the middle of the empodium, *i.e.*, to the bend of the claw, as this is the point at which the eye naturally rests in comparing the fourth with the other joints.

In describing *P. neavei*, sp. n., many details of generic value only have been mentioned; in the others, comparative features mainly have been emphasised.

The available evidence suggests very strongly that the species of *Pleurotropis* will prove to be hyperparasites upon other parasitic Hymenoptera; and if this be so, they must be regarded in many cases as noxious insects.

Key to Species of Pleurotropis, *Förster, described from Africa and Persia.*

1. Wings limpid 2
   Wings distinctly tinged with brown; mandibles large, falcate, protruding .. .. *clinognathus*, sp. n.
2. Hind tibiae concolorous to apex, metallic or non-metallic 4
   Hind tibiae dark metallic green, with the apical one-fifth or one-sixth, or at least the extreme tip, paler, non-metallic 3
3. Entire mesonotum (mid lobe, parapsides, axillae, and scutellum) with rather fine reticulation, the pattern strongly raised; mid keels of propodaeum basally contiguous; size over 2 mm. .. .. *illustris*, sp. n.
   Mesonotum with coarse raised reticulation on base of mid lobe, smoother at sides of apex and base of scutellum in middle, keels well apart at base, brilliant green. $1\frac{3}{4}$ mm. .. *neavei*, sp. n.
   Only the tip of the tibia pale, larger (2 mm.) and slightly duller .. .. *neavei*, var.
4. Small species; ♀ not more than 1·25 mm. 5
   Larger species; ♀ 1·35–1·75 mm., more stoutly built 6
5. Hind tibiae translucent brown, in some specimens faintly metallic; antero-median scutellar surface smooth in both sexes .. .. *telenomi*, Crawf.
   Hind tibiae darker, with blue reflections; antero-median scutellar surface smooth in female, raised in male .. .. *violacea*, sp. n.
6. Entirely shining black, but not metallic, save occasionally on funicle and hind legs; head very broad, malar space reduced, truncate; lateral keels delicate .. .. *africana*, sp. n.
   More or less extensively metallic on head and thorax; lateral keels normal 7
7. Mid region of scutellum gleaming from base to apex 9
   Mid region of scutellum posteriorly with raised pattern 8
8. Pattern of scutellum entirely coarse and raised, outer tooth of mandible distinctly smaller than the inner, whose edge is simple .. .. *mediopunctata*, sp. n.

Scutellum in the middle anteriorly smooth, reticulate, not raised, pattern finer; mandibular teeth subequal, inner edge apically serrate .. .. *homoea*, sp. n.

9. Pre-apical hollows of propodaeal peduncle shining; mesonotal sculpture coarse; vertex reticulate .. .. .. *nigripes*, sp. n.
   Pre-apical hollows dull; mesonotal sculpture fine; vertex smooth .. .. *amaurocoela*, sp. n.

Pleurotropis neavei, sp. nov. (figs. 1, 2, 5, 9).

♀.—*Head* broader than thorax (5 : 4), much broader than long (5 : 2), the length being measured across the vertex; occiput very concave, the edge sharp. Eyes large, densely clothed with whitish pubescence; malar space distinct, triangular. Frons slightly prominent at the base line of the eyes, just above which the antennae are set; vertex coarsely reticulate, seen from above shining green. Posterior ocelli about twice as far from one another as from the ocular edge. Behind the posterior ocelli the vertex is a little excavated and smoothed towards the postero-lateral angle of the occiput, but the reticulation reappears just before the occiput is reached. Occiput sharply defined, surface down to the neck (facing the prothorax) dull, reticulate, dark purple. Frons coarsely reticulate to below the anterior ocellus (which divides a line drawn from the apex of either scape to the opposite posterior ocellus), and concolorous with the vertex; its surface up to this point flat or slightly convex, but below the anterior ocellus the face is hollowed, consisting of two inclined finely reticulate plates, which unite rather indistinctly in the middle, but with clear sutures above from the anterior ocellus to the upper margin of the eye; the face here has aeneous reflections, but from in front is dark green; the lower mid line of the frons and the clypeus, which is gently concave on the oral edge, is smooth. Above the middle of the frons the orbits are subparallel, but they diverge both towards the occiput and the genae. All the frons wide, the shortest distance between the eyes being $\frac{1}{3}$–$\frac{1}{2}$ greater than the width of the eye seen from the same aspect. Genae duller, with short pubescence, at most showing a faint, purplish reflection. On the occipital edge 4 bristles, viz., a median pair with one on each side aligned after an interval with a row of five bristles, which fringe the orbit, the last of this row standing at the level of the apex of the scape; below this on each side a row of 5–6 minute bristles; across the clypeus, above the mouth edge, 6 bristles (3, 3) and a pair below the scrobes; a single hair behind the anterior ocellus and one inside each of the posterior ocelli; between the ocellar triangle and the apices of the scapes two pairs of lateral medianly convergent bristles.

Antennae eight-jointed (fig. 2, *b*): scape, pedicel, one ring joint, three funicular and two in the club—the last with a terminal spur. Scape slender, five times as long as broad, on ventral edge 6–7 hairs, dorsally about three. Pedicel about twice as long as broad, shorter than first funicular joint. Ring joint very small; under a high power, apparently consisting of at least two laminae, closely appressed. The funicular joints, especially the second and third, pedunculate anteriorly, first longest, second and third decreasing slightly; first joint of club much bigger than the second. Joints 4-8 show three kinds of structure: (*a*) long scattered hairs, (*b*) short mushroom-like

hairs, and (*c*) " sensory " grooves, giving rise to clear narrow blade-like pieces of chitin. Entire antennae dark shining metallic green, hairs whitish. Length, ·6 mm.

Mouth-parts : mandibles (fig. 5, *b*) triangular, bidentate, outer tooth slightly sharper and longer, inner edge of the second serrate near apex, 3–4 hairs on outside. Stipes dense and black ; one hair behind the maxillary palpi ; galea with about seven hairs, mainly towards the apex. Both palpi one-jointed, the labial long, three-fourths of the maxillary, with the usual long terminal bristle and another median or sub-basal.

Thorax shining green, the sternal area similar, but darker. *Prothorax* entirely shining and smooth, brilliant green, with a suggestion of blue, with six strong pale bristles (3, 3) on the anterior edge, which is sharply defined ; these bristles extend to the bend of the parapsidal furrows. *Mesonotum* with the parapsidal furrows distinct ; mid lobe coarsely reticulate anteriorly in the centre, the pattern raised and extending to the suture, the sides anteriorly still reticulate but not raised, the

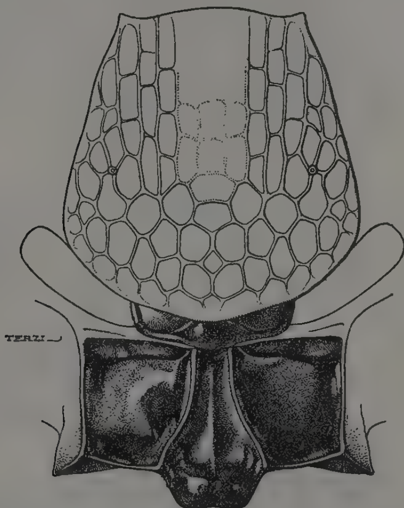

Fig. 1. *Pleurotropis neavei*, sp. n. ; scutellum, metanotum and propodaeum.

reticulations becoming drawn out towards the apex (*i.e.*, posteriorly). On each side towards the furrows is a dimpled or depressed, smooth, setigerous area ; besides these two bristles the mid lobe bears a pair anteriorly. Lateral lobes smooth and shining—in reality finely reticulate, but not with raised pattern—with two bristles, one before the axilla and one at the anterior angle. Axillae with one bristle, invading parapsides somewhat deeply, and with a similar surface. *Scutellum* (fig. 1) with two bristles ; anterior median area smooth, with ridges or furrows on each side ; posteriorly the furrows are more and more distinctly crossed by transverse ridges, till the whole hind area is reticulate. *Metanotum* narrow, mid portion green, shining, smooth ; sides dull purplish and depressed. *Propodaeum* (fig. 1) large, entirely smooth

and shining, with two short angular projections and as hort neck for the reception of the petiole. Entire posterior edge ridged; two median and two lateral keels, the spiracles outside the latter. At the metanotal suture the median keels are from one another about one-seventh of the distance between the laterals, but posteriorly they diverge considerably, till at the posterior edge they are apart over one-third the

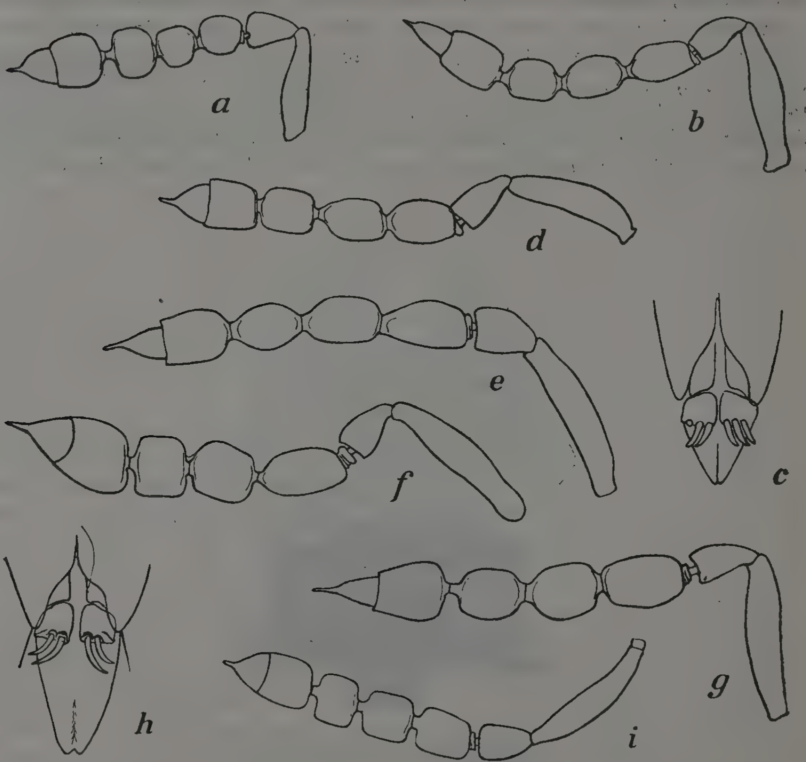

Fig. 2. *a*, antenna of *Pleurotropis africana*, ♀; *b*, antenna of *P. neavei*, ♀; *c*, genitalia of *P. neavei*, ♂; *d*, antenna of *P. clinognathus*, ♀; *e*, antenna of *P. mediopunctata*, ♀; *f*, antenna of *P. homoea*, ♀; *g*, antenna of *P. nigripes*, ♀; *h*, genitalia of *P. nigripes*, ♂; *i*, antenna of *P. amaurocoela*, ♀.

distance between the lateral keels. An area is thus enclosed in which there rises a slight median keel, flanked by two hollows separated slightly from one another. The short stalk of the propodaeum is at first a little depressed, then raised. Thus, the keel or ridge separating the hollows fails before the extreme apex of the propodaeum. Stigma oval, rimmed (fig. 9, *a*); pleurae shining green, reticulate.

Wings: fore wings with the marginal long, more than twice the length of the submarginal; radius nearly sessile, with four cells, shorter than the post-marginal. Length, 1·2 mm.; breadth, ·6 mm. Hind wings with cilia rather long. Length, 1 mm.; breadth, 2·5 mm.

Legs: fore legs with the coxae triangular, moderately swollen, reflexed apically on outside; femur slightly swollen, with 10–12 ventral bristles, of which the last (subapical) is longest; tibia as long as the femur, with two apical ventral spurs; the first three joints of the tarsus subequal, the last to tip of claw double its predecessors (see table below). Entire leg to near the tip of tibia black, with metallic green reflections, apex paler, non-metallic; in cleared preparations the knees are also narrowly pale, but this cannot be seen in carded examples; first three tarsal joints pale, fourth darker, especially towards the tip. Mid legs slender, coxae with no apical reflection; femur with three basal ventral bristles, bare thence till near the apex, where there is a single long bristle above the ventral edge; tibia longer than femur, with a strong apical ventral flat spine, which is as long as the first tarsal joint. Mid leg coloured like the first, but the tip of the femur is more extensively pale, and the apex of the tibia also. Hind legs with the coxae large, swollen; femur equal to the tibia, with about eight very short ventral bristles and one long subapical; apical bristle of tibia stout, the extreme tip dark, nearly half as long again as first tarsal joint.

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.
Fore	**20**	**22**	**22**	**44**
Mid	**40**	**30**	**25**	**45**
Hind	**30**	**30**	**30**	**50**

Measurements made from base of joint along dorsal edge to the base of succeeding joint.

Abdomen with the petiole moderate, with lateral keels above and below, the surface punctate and dull purplish. First tergite occupying rather more than half of the visible surface of the abdomen, shining blue green on the posterior edge and elsewhere, except on the postero-median half, which is dull purple and coarsely reticulate. The remaining tergites have the same dull purple lustre except before the suture, where they are shining blue green. Abdomen generally depressed above slightly carinate below, basally ovate and terminally pointed. Ovipositor not projecting; free portion of sheath one-tenth of the base. The first tergite is practically bare, but behind it the segments are clothed with soft whitish hairs, set mainly at the sides, there being a median posteriorly contracting glabrous area.

Length, 1·62 mm.; alar expanse, nearly 3 mm.

♂.—I am not able to describe this sex in detail, as only fragments of one specimen are available. It appears to be smaller and stouter in build, with a bronzy tint over the prevailing metallic green. Antennae barely ·6 mm.; scape shorter and more

expanded than in the ♀; sensory channels less elongate, almost rounded; pedicel longer than first funicular joint; joints of the funicle subequal, decreasing slightly, bead-like, with longer stalks. No subapical ventral bristle on hind tibia.

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.
Fore	15	25	20	30
Mid	35	25	20	45
Hind	25	30	30	45

NYASALAND: Mt. Mlanje, 3. vii. 13 (*S. A. Neave*).

Holotype—a ♀.

A series of eight females was bred by Mr. Neave from the pupa of a butterfly (*Charaxes* sp.). The insect is not improbably a hyperparasite on some species of *Chalcis*.

P. neavei is apparently a close ally of *P. howardi*, Crawford (Bull. U.S. Dept. Agric., Tech. Ser. no. 19, pt. ii, p. 23), but differs in the smaller size (less than $1\frac{3}{4}$ to 2 mm.) and the apically pale posterior tibiae.

Pleurotropis neavei, var.

♀.—The mandibles are essentially as in the type, and the differences in sculpture (slightly coarser) are such as might be expected with the greater size. *Length*, 2 mm.; alar expanse, over 3 mm.

GERMAN EAST AFRICA: Bukoba, 2 ♀♀ from cocoons of *Apanteles* sp., 10. vi. 12 (*C. C. Gowdey*).

Pleurotropis clinognathus, sp. nov. (figs. 2, 3, 4, 5, 9).

A purplish black species, with blue-black or purple reflections.

♀.—*Head*: eyes rather sparsely haired; vertex and frons indistinctly reticulate except on the ocellar triangle; from the ocelli to the suture the frons is shining blue-black, while below, on the area subtended by the scapes, the surface is distinctly though finely reticulate and dull purple in colour. Clypeus shining. Mandibles relatively large (fig. 5, *e*), protruding from the mouth and easily visible, bidentate, falcate, the outer edge long and curved, the outer tooth long and sharp, the inner small.

Antennae (fig. 2, *d*) hardly anywhere metallic; in transmitted light, the scape, pedicel and eighth joint, even when unmounted, are translucent; the other joints are dark, with blue reflections. Pedicel equal to the first funicular joint. Length, ·55 mm.

Thorax: mid lobe of *mesonotum* with a very coarse raised reticulation. Parapsidal furrows after the bend exceedingly hard to see, but from the bend there is a prominent ridge on each side of the apex of the mid lobe running *inside* the depressed setigerous area and making a narrow abscissa on the scutellar suture. These ridges, however, are not true parapsides, but rise as the meeting lines between

the dissimilar sculpturing of the depressed area and the mid apex of the mid lobe. The depressed area is thus dull (smooth and shining in *neavei*) and the bristle rises from a raised base. *Scutellum* (fig. 3) nowhere smooth, but more shining than the mid lobe; pattern slightly raised and longitudinally drawn out. Axillae dull, finely reticulate. *Propodaeum* (fig. 3) with the median keels nearer one another than in *neavei*, one-eighth the distance between the lateral keels, no raised portion or ridge enclosed; near the short neck the central keels diverge slightly, enclosing two hollows. Lateral keels subparallel and short, the short projection behind each being rounded, not pointed. Spiracular area outside the keels narrowed (fig. 9, *b*).

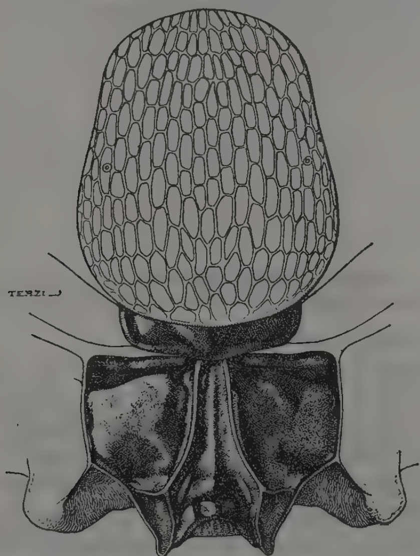

Fig. 3. *Pleurotropis clinognathus*, sp. n.; scutellum, metasternum and propodaeum.

Wings tinged with clear brown.

Legs: all the coxae and femora, except the tips of the posterior pairs, dark, but almost without reflections; all the tarsi pale translucent, fuscous or brown, the last joint neither wholly nor partly black; fore and mid tibiae dark to beyond the basal half, paler thereafter; hind tibiae nearly uniformly pale. Spur longer than the first tarsal joint.

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.
Fore	15	25	20	40
Mid	35	35	20	40
Hind	25	40	30	40

Abdomen: first tergite covering half the visible surface, entirely shining, dark bluish green; tergites 2–4 subequal, 5 twice as long as 4, 6 a little longer than 4. All these tergites purplish and shining, being so little striate or punctate that there is no interference with the light reflection. Free portion of sheath one-sixth of the base.

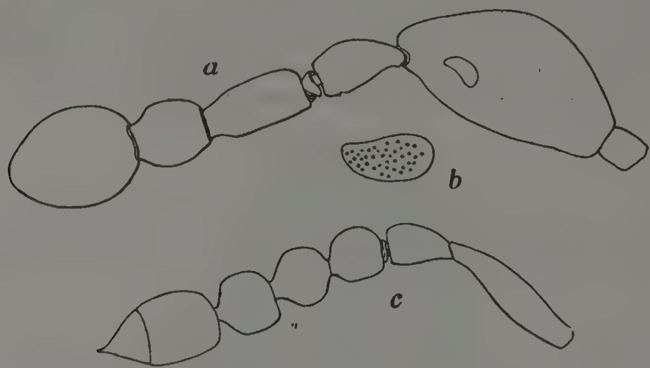

Fig. 4. *Pleurotropis clinognathus*, sp. n.; *a*, antenna of ♂; *b*, sense-organ on antenna of ♂; *c*, antenna of *P. telenomi*, Crwf.

Length, 1·37 mm.; alar expanse, 2·75 mm.

♂.—*Head*: The ♂ differs conspicuously from the ♀ and from the ♂♂ of the other species now described in the antennae (fig. 4, *a*, *b*). These are apparently composed of six joints; scape, pedicel, ring joint, two funicular and one club. The scape is extremely thick, deep and swollen, the length being to the breadth as 8 : 5. Pedicel normal, five-twelfths of the scape in length. First funicular joint cylindrical, longer (7 : 5) and narrower (3 : 4) than the more globose second joint. Club joint single, swollen, oval, without terminal spur, longer than broad (4 : 3) and shorter than the sum of the funicular joints (2 : 3). The whole antenna is bristly (except the sparsely clad pedicel), and the scape, besides being covered dorsally with a coarse raised reticulation, bears near the apex a perforated oval plate. Length of antenna, ·48 mm. The eyes are distinctly hairy.

Wings: the forewings, as compared with those of the ♀, are much less robust and shorter.

Legs rather stronger and possibly more metallic on the femora.

Thorax: in the mid lobe of the mesothorax the ridge inside the parapsidal furrows is fainter posteriorly. The cells on the scutellum a trifle wider, especially posteriorly.

Abdomen: the first visible tergite covers one-half of the whole surface.

Length, 1·37 mm.; alar expanse, 1·8 mm.

SOUTHERN NIGERIA: Ibadan, 50 ♀♀, bred from unrecorded host, emerged 2. ii. 14 (*Dr. W. A. Lamborn*).

GOLD COAST: Aburi, 7 ♂♂ and 37 ♀♀ bred from horned wasp (*Synagris cornuta*, F.), and 1♂ and 43 ♀♀, presumably from the same host, 1912–13 (*W. A. Patterson*).

Holotype—a ♀ from Ibadan.

Pleurotropis nigripes, sp. nov. (figs. 2, 5, 6, 7, 9).

Dark shining green on head, thorax and base of first abdominal segment, remainder of abdomen and pleurae blue or purplish.

♀.—*Head* (fig. 7, *b*) : sculpture of the vertex distinct, though not so pronounced or raised as on the thorax, agreeing in this respect with *P. clinognathus*. The hollows behind the posterior ocelli distinct, smooth extensively towards the eye margins ; reticulation most distinct within the ocellar triangle. Eyes almost bare, the pubescence short and sparse. Mandibles not deeply bidentate (fig. 5, *f*), inner tooth broader, with its inner edge shortly serrate at the apex. *Antennae* entirely dark and metallic, pedicel short, first joint of funicle longest and broadest. Length, ·68 mm.

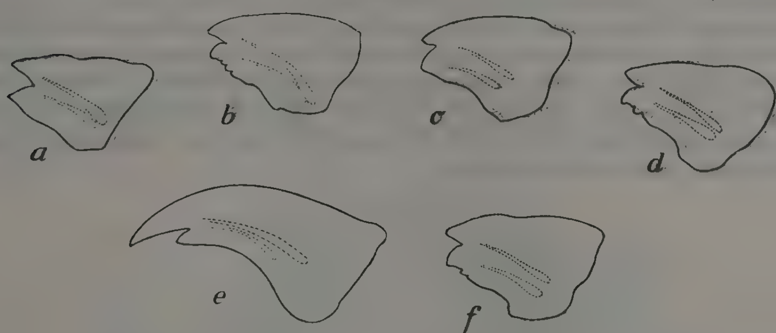

Fig. 5. Mandibles of :—*a, Pleurotropis africana* ; *b, P. neavei* ; *c, P. mediopunctata* ; *d, P. homoea* ; *e, P. clinognathus* ; *f, P. nigripes*, spp. n.

Thorax : *pronotum* smooth and shining, but behind the anterior ridged edge are numerous very short subparallel ridges not reaching beyond one-third backwards ; they are imperceptible separately save in a good light, but their effect is to make the anterior edge duller. *Mesonotum* with the mid lobe rather coarsely reticulate to the level of the posterior (apical) pair of bristles, the pattern being raised. From the bristles to the scutellum the apex of the mid lobe is striate, only the longitudinal lines of the reticulate pattern being raised. Before the scutellum the furrows are rather deeply marked for a short distance. Lateral lobes and axillae mainly striate-reticulate. *Scutellum* antero-medianly smooth, shining and impunctate, as in *P. neavei*, but less broadly so ($\frac{1}{3}$ as opposed to $\frac{1}{2}$) with about five ridges on each side. The smooth median area continues to the metanotum, before which there is at most a weak striation with feeble reticulation. The posterior third is not, as in *P. neavei*, raised again into a bold pattern. *Propodaeum* narrower than in *P. neavei*, the posterior knob broad ; within the median keels is a secondary central keel running the whole length of the enclosed space ; distally on both sides the preapical hollows are shining.

Wings : fore wings apically rounded ; length 1·2 mm. ; breadth, ·55 mm. hind wings, length, ·95 mm. ; breadth, ·25 mm.

Legs: from the coxae to the tip of the tibiae all three pairs black and metallic; the last joint of all the tarsi wholly black, the other three clear white. The apical spur of the mid tibia is hardly as long as the first tarsal joint.

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.
Fore	24	25	20	45
Mid	50	30	30	45
Hind	40	40	30	50

Abdomen: first tergite occupying half the surface, with a dim triangular median area, the apex of which lies behind the petiole, while the base (narrowly separated from the suture) extends across the median two-thirds. This dimmer area is caused by numerous minute punctures giving rise to microscopic hairs (*cf. P. neavei*, where the surface is actually dull and reticulate). The succeeding segments show, (*a*) a basal shining belt, (*b*) a minutely punctate or roughened median band, and (*c*) the usual gleaming sutural edging.

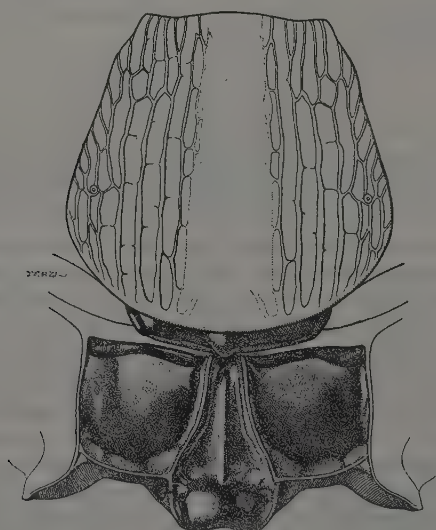

Fig. 5. *Pleurotropis nigripes*, sp. n.; scutellum, metanotum and propodaeum.

Length, 1·5 mm.; alar expanse, 3 mm.

♂.—*Antennae* with the pedicel less than two-thirds of the first funicular joint. Joints of funicle decreasing; club long, with equal joints. Length, ·7 mm.

Wings: fore wings very truncate at apex; length, ·97 mm.; breadth, ·48 mm. Hind wings, length, ·88 mm.; breadth, ·20 mm.

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.
Fore	20	25	20	40
Mid	40	30	25	40
Hind	35	35	25	40

The apical hind tibial spine distinctly longer than the first tarsal joint.

Southern Nigeria : Ibadan, 2 ♂♂ and 8 ♀♀, bred, along with au undetermined *Eurytoma* sp., from cocoons of an undetermined Braconid, vii. 1913 (*Dr. W. A. Lamborn*).

Holotype—a ♀.

Pleurotropis amaurocoela, sp. nov. (figs. 2, 7, 8, 9).

Similar to *P. nigripes*, from which it differs mainly in the antennae, vertex and propodaeum.

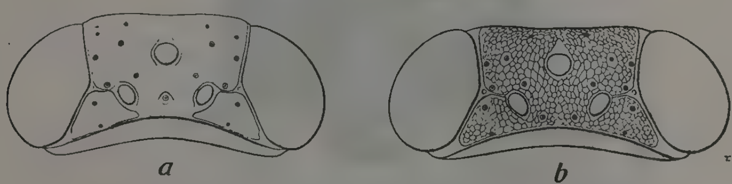

Fig. 7. Heads of :—*a*, *Pleurotropis amaurocoela*, sp. n. ; *b*, *P. nigripes*, sp. n.

♀.—*Head* (fig. 7, *a*) : eyes distinctly but not densely hairy (almost bare in *P. nigripes* and *homoea*). Vertex and frons to the suture smooth and gleaming, the surface hardly disturbed, except along the edge of the occiput, in the middle, behind the ocellar triangle. The space between the anterior ocellus and the apices of the scapes is shining dark blue green. In *nigripes* the corresponding area is furrowed or raised reticulate, dark green, and only a little less rough in *homoea*.

Antennae short, compact, shining dark blue ; funicular joints thick, the first slightly longest (fig. 2, *i*). Length, ·55 mm.

Thorax : *mesonotum* green, with purple reflections near the suture. Mid lobe with moderately fine reticulation, hardly at all raised (coarse and raised in *nigripes*), and drawn out towards the apex, at the side of which are two setigerous foveolae, the setae being on a slightly raised base. Over these hollows is a dull purplish tinge. *Scutellum* (fig. 8) with the median area (over one-third) bright shining green throughout ; at the sides the reticulate pattern long drawn out *Propodaeum* (fig. 8) with the central keels widely apart at base and a weak median keel within, preapical hollows dull purplish in contrast to the brilliant green of the rest of the surface.

Abdomen with the first abdominal tergite rather more extensive than in *nigripes*, shining green at the sides and base; the rest purple, equally smooth. With eyepiece v. and objective *a* no hairs can be differentiated on the purple surface, whereas in *nigripes* with the same power they are apparent.

Length, 1·5 mm.; alar expanse, over 3 mm.

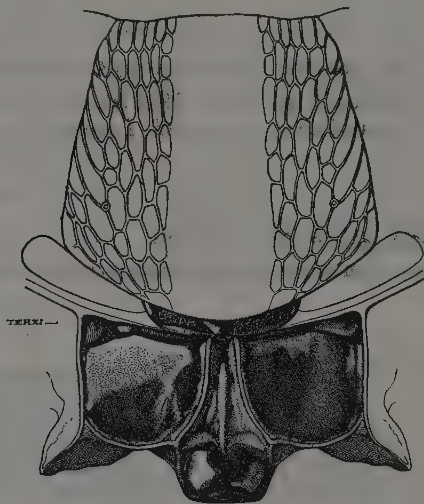

Fig. 8. *Pleurotropis amaurocoela*, sp. n.; scutellum, metanotum and propodaeum.

Egypt: Cairo, 1 ♀, bred (along with a Pteromalid) from a microlepidopterous larva (*Pyroderces simplex*, Wlsm.) in cotton bolls (*W. Draper*—Brit. Mus.).

Northern Nigeria: Aguji, Ilorin Province, 3 ♂♂ and 6 ♀♀, bred from cocoons of a Braconid (*Apanteles* sp.) parasitic on the cotton leaf-roller (*Sylepta derogata*, F.), 18.ix.13 (*Thos. Thornton*).

Nyasaland: Dedza, 2 ♀♀, bred with *Tetrastrichus* sp., from *Sylepta derogata* (*E. Ballard*).

Holotype—a ♀ from Dedza.

Pleurotropis homoea, sp. nov. (figs. 2, 5, 9, 10).

Closest to *P. nigripes*, but separated from it by size, colour, sculpture of thorax, etc. A larger duller insect; the metallic reflections on the head and thorax very dark green; abdomen practically black, with blue and purple reflections.

♀.—*Head* smoother on the vertex, eyes bare. *Antennae* (fig. 2, *f*) with the joints of the funicle increasing in width abruptly (hardly at all in *nigripes*). Length, ·67 mm.

Wings : fore wings, length, 1·15 mm. ; breadth, ·55 mm. Hind wings, length, 1 mm.; breadth, ·25 mm.

Thorax : mid lobe of *mesonotum* more finely reticulate, with foveolae before the suture, the reticulation at the apex not drawn out into ridges. Mid anterior area of *scutellum* (fig. 10) finely reticulate, but hardly at all raised ; at the sides anteriorly the cells of the network are longer than broad, but the ridges are neither so continuous nor so raised as in *nigripes*. Posteriorly the scutellum is reticulate, while in *nigripes* the smooth area extends to the metanotum. *Propodaeum* (fig. 10) with the median keels

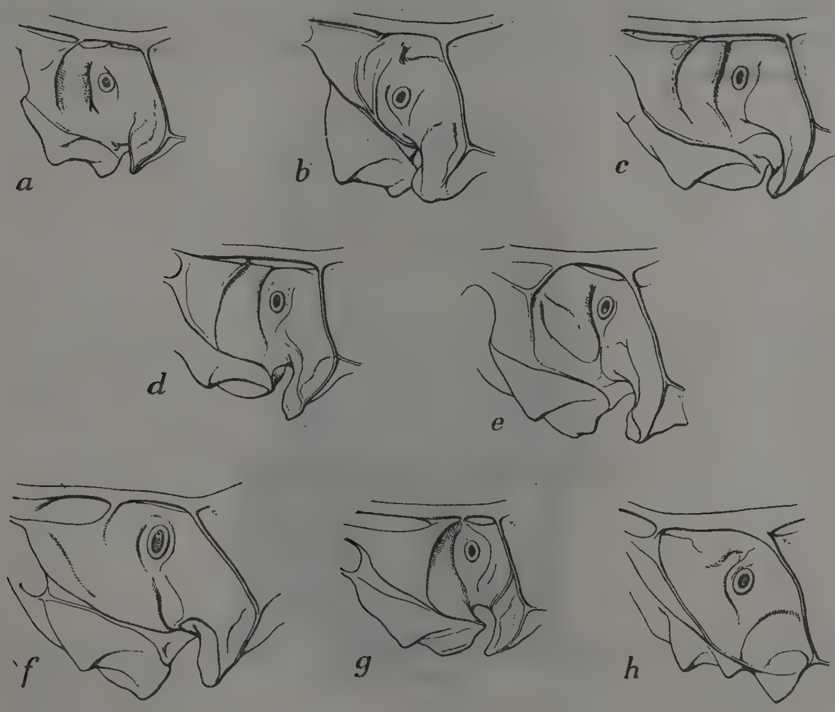

Fig. 9. Pleurae of the propodaeum of :—*a*, *Pleurotropis neavei* ; *b*, *P. clinognathus* ; *c*, *P. nigripes* ; *d*, *P. amaurocoela* ; *e*, *P. homoea* ; *f*, *P. mediopunctata* ; *g*, *P. africana* ; *h*, *P. illustris*.

closer and the excavation before the insertion of the petiole pitted and dull, not smooth and shining as in *nigripes*. In *nigripes* the areas enclosed between the lateral and the median keels are smooth, shining metallic green ; in *homoea* the corresponding areas are much darker, gleaming, obscurely reticulate (though not raised), and next the posterior margin are a number of irregular foveolae which further darken the edge.

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.
Fore	20	25	20	40
Mid	40	30	30	40
Hind	40	40	30	—

Abdomen : the first segment occupies at least five-eighths of the exposed surface.

Length, 1·75 mm. ; alar expanse, 3 mm.

NYASALAND : Zomba, 2 ♂♂ and 10 ♀♀, bred from larvae of a Noctuid moth (*Busseola fusca,* Hmp.), which is very destructive to maize (*E. Ballard*).

Holotype—a ♀.

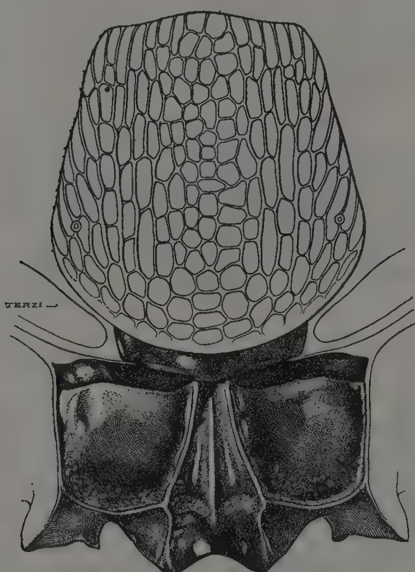

Fig. 10. *Pleurotropis homoea,* sp. n. ; scutellum, metanotum and propodaeum.

Pleurotropis mediopunctata, sp. nov. (figs. 2, 5, 9, 11).

Blue-black with metallic reflections, and little green anywhere.

♀.—*Head* with slight greenish reflections on the face, mingled with blue. Reticulation of the head somewhat coarse and raised especially between the ocelli and the apex of the scapes. *Antennae* strongly metallic (fig. 2, *e*). Length, ·68 mm.

Thorax : pronotum with the shining surface on the anterior half considerably disturbed by hollows and short rugae, so as to appear dim ; the six bristles are darker than usual. *Mesonotum* with the reticulations of the mid lobe much raised, but

the depressed triangular setigerous areas lying one on each side of the apex of the lobe are smooth; the parapsidal furrows (whose abrupt bending is plainly visible in this species) bounding this smooth spot on the outside, are deepened. *Scutellum* (fig. 11) entirely covered by a raised pattern which anteriorly tends to form ridges, and posteriorly consists of a very coarse reticulation (cf. the same region in *P. neavei*). *Propodaeum* (fig. 11) with the median keels very close together basally, rather more than one-tenth the distance between the laterals; the enclosed space not carinate, but

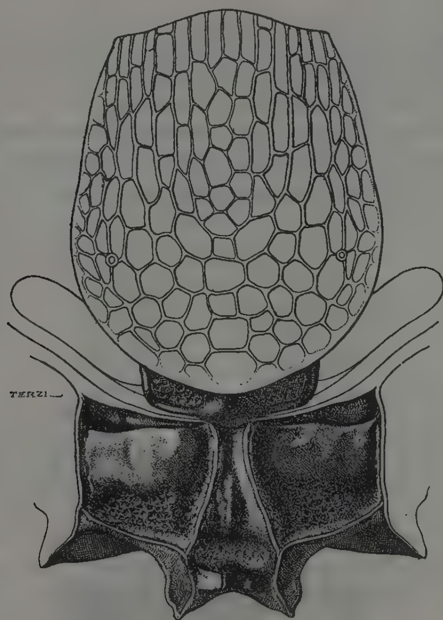

Fig. 11. *Pleurotropis mediopunctata*, sp. n.; scutellum, metanotum and propodaeum.

slightly pitted posteriorly. The area contained by the expanded ends of the keel is deeply hollowed and the cavity is dull, owing to its surface being punctured; the whole upper posterior edge before the posterior keel is for some distance punctate and dull.

Wings: fore wings, length, 1·3 mm.; breadth, ·6 mm. Hind wings, length, 1 mm.; breadth, ·25 mm.

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.
Fore	25	25	20	40
Mid	30	35	25	50
Hind	—	—	—	—

Abdomen with the first segment occupying three-fourths of the exposed surface, with a broad, dim, minutely punctate region bearing microscopic hairs; the base of this dim area extends practically across the suture. Anteriorly and at the sides, gleaming metallic blue-green; the remaining segments considerably telescoped, shining black.

Length, 1·6 mm.; alar expanse, 3 mm.

SOUTHERN NIGERIA: Ibadan, 4 ♀♀, bred from pupa of a Coccinellid beetle, vii.1913 (*Dr. W. A. Lamborn*).

Pleurotropis africana, sp. nov. (figs. 2, 5, 9, 12).

A broad-headed black species, differing from the others described in the weak lateral keels of the ♀, and the reduced malar space.

♀.—*Head* black, with a purplish lustre, extremely broad, much broader than the thorax at its widest and equalling the length of the abdomen. Vertex rather long, with the face moderately reticulate, the pattern hardly raised. Eye large, extending

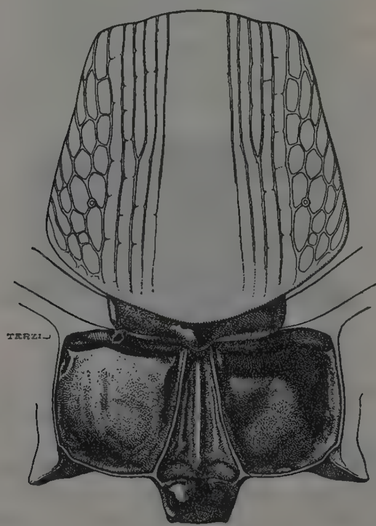

Fig. 12. *Pleurotropis africana*, sp. n.; scutellum, metanotum and propodaeum.

almost to the mandibles and narrowed ventrally; thus the malar space is practically absent, but the genae are correspondingly increased. Mandibles (fig. 5, *a*) deeply cleft into two equal teeth, the edge of the inner of which is not serrate.

Antennae (fig. 2, *a*) with the joints of the funicle remarkably bead-like, subequal—the middle one, if any, the shortest—broadening distinctly towards the club, joint six being broader than long; all joints strongly shining, dark metallic green. Length, barely ·5 mm.

Thorax with the *pronotum* gleaming posteriorly, anterior half reticulated and dull, hairs dark. *Mesonotum* with the mid lobe reticulate, the pattern being drawn out towards the apex; parapsidal furrows rather deep, no depressed differently sculptured side areas at the apex of the lobe, but in their place, almost on the furrows, a rather deep, elongate fovea; apex distinctly emarginate; parapsides striate, reticulate. Axillae and side of scutellum not dull, but reticulate and gleaming like the rest of the thoracic surface. *Scutellum* (fig. 12) smooth on the median third from the base to the apex, with about four longitudinal ridges on each side, between which there are practically no transverse striae. *Propodaeum* (fig. 12) broad, very smooth and shining black. Central keels distally wide apart, containing a well defined central ridge and traces of two others. Depressions before the apex small, the knob itself broad and gleaming. Lateral keels delicate, difficult to see from above because of their fine edge and the black colour of their surroundings.

Abdomen with the petiole broad and stout; first tergite covering more than one-half, the disc finely reticulate, in most lights punctate, gleaming, sutural margin broad. The following tergites, like the first, show a broad smooth shining suture with a narrow dull punctate band in front. Rows of hairs on tergites 2–5 continuous and not medianly interrupted.

Wings: fore wings very truncate apically; submarginal half the marginal, radius almost sessile, with four cells. Length, 1 mm.; breadth, .52 mm. Hind wings, length, ·85; breadth, ·25.

Legs generally heavier than in the other species, the coxae especially being more swollen and proportionally larger. All are black to the apices of the tibiae, any paleness of the knees demonstrable only in cleared specimens. Fore legs with the last (pre-apical) bristle of the ventral row long and stout, not similar to the others of the row, as it is in *P. neavei*; fourth tarsal joint two and one-third times joint 3, entirely darkened; the others are pale, though 2 and 3 are slightly infuscated. Mid legs with even the head of the femur dark; apical spur reaching middle of tarsal joint. Hind legs with the tibia considerably flattened; apical bristle very stout, dark at tip and equal to the first two tarsal joints.

Proportions of Tarsal Joints.

	i.	ii.	iii.	iv.
Fore	15	15	15	35
Mid	24	20	20	40
Hind	25	25	20	45

Length, 1·27 mm.; alar expanse, 2·5 mm.

♂.—Very different in colour from the ♀, being bright cupreous or bronzy all over. The metallic green on the antennae is thus masked, but it reappears on the hind femora.

Antennae with the funicular joints not broadened towards the apex; all practically of the same diameter. *Scutellum* with a reticulate pattern on the median area and

the longitudinal ridges bolder than in the ♀. *Propodaeum* with the lateral keels distinct; spiracle large. *Abdomen* with the petiole longer than in the ♀ and very stout; first tergite more extensive.

Length, 1·25 mm.; alar expanse, barely 2·5 mm.

NYASALAND: Zomba, 2 ♂♂ and 12 ♀♀, bred, along with ♂♂ of a Eupelmine and a ♀ Scelionid from eggs of a Hemipteron (?) (*E. Ballard*).

Holotype—a ♀.

Pleurotropis violaceus, sp. nov.

A small deep blue species nearest to *P. telenomi*, Crawf. (1911), from Uganda, but slightly larger, darker and more metallic.

♀.—*Head* with the vertex and frons shining blue-black, obscurely reticulate. *Thorax* coloured like the vertex. Mesonotum evenly reticulate, the furrows not distinctly marked; apex of mid lobe not so deeply emarginate as in *P. telenomi*. Axillae further apart. Scutellum medianly almost smooth, but even in the centre a masked reticulation can be detected. *Abdomen* violet or blue-black, shining; the first tergite rather more extensive than in *telenomi*. *Legs* blackish brown with blue-black metallic reflections, especially on the hind tibiae.

Length, over 1·25 mm.; alar expanse, 2½ mm.

♂.—Bronzy all over. *Head* broad; vertex and frons to suture, metallic blue, entirely raised reticulate. *Antennae* shining metallic blue; funicle joints bead-like, stout, subequal; pedicel about equal to the first funicular joint. *Thorax* with the mesonotum entirely reticulate; the pattern on the scutellum slightly coarser. *Abdomen* blue-green; the first tergite occupying about five-eighths of the surface; smooth, shining, the other segments telescoped. *Legs* stronger than in *telenomi*, dark, shining, metallic blue-black; those of the latter more or less transparent brown with indefinite reflections.

Length, nearly 1 mm.; alar expanse, over 2 mm.

NYASALAND: Zomba, 1 ♂ and 1 ♀, bred, with *Tetrastichus* sp., from eggs of a Lymantriid moth (*Heteronygmia leucogyna*, Hmp.), which is very destructive to leaves of mahogany trees, 29. v. 13 (*E. Ballard*).

Holotype—a ♂.

Pleurotropis illustris, sp. nov. (figs. 9, 13).

A large brilliant green form, with the median keels basally contiguous.

♀.—*Head* broader than thorax; vertex and frons to the scrobes, raised, reticulate, purple and violaceous green; depressed area behind posterior ocelli likewise reticulate. Eye orbit gleaming near the occipital ridge; eyes sparsely haired, their inner frontal edge decidedly concave. Malar space rather short; lower face reticulate and with hardly any metallic reflections.

Antennae rather widely separated; the joints cylindrical rather than bead-like, brown, with a greenish metallic gleam up to the end of the funicle.

Thorax: *mesonotum* evenly and rather finely (as regards the mesh) reticulate, the whole pattern boldly raised, brilliant metallic green. Parapsidal furrows distinct anteriorly, and traceable to the suture by varying the position of the insect,

bent rather abruptly (as seems generally the case in *Pleurotropis*) at about the middle of the mid lobe; the latter apically a little emarginate. *Scutellum* (fig. 13) nowhere smooth, all over with the same sculpture and colour as the rest of the mesonotum; sides dull purplish. Dorsal surface of *metanotum* obscurely reticulate and gleaming, sunken side areas shining more brightly; colour green. *Propodaeum* (fig. 13) with the central keels basally contiguous, distally widely divergent and running not to the sides of the posterior neck or peduncle to which the petiole is attached, but to points on the posterior upturned edge, not far from the postero-lateral angle. Neck with no depressions in front and sending back a narrow keel towards the narrowing mid keels; lateral keels parallel, well defined. Spiracular area large (fig. 9, *h*).

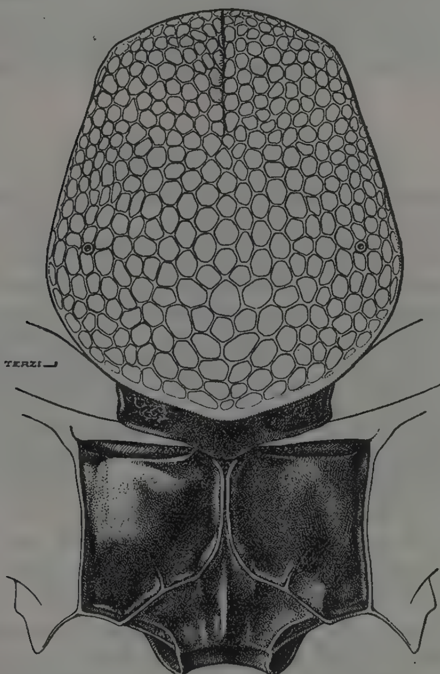

Fig. 13. *Pleurotropis illustris*, sp. n.; scutellum, metanotum and propodaeum.

Wings: marginal vein with about 25 fringing bristles, very long, more than twice the length of the submarginal.

Legs: all coxae and femora dark metallic green; trochanters non-metallic, paler; all the tibiae, except the apical one-fifth or one-sixth, dark and metallic; tips of fore tibiae brown, non-metallic; tips of mid and hind tibiae white; fore tarsus brown, the last joint darker; hind and mid tarsi white, except the last joint, which is blackish brown.

Abdomen with the first tergite entirely shining, deep green with a bluish tinge; occupying one-quarter of the visible surface. Remaining tergites with a moderately broad shining green edge before the suture; the rest of the surface dull purplish and coarsely reticulate. Tergite 6 nearly all reticulate; tergites 3–5 subequal in length, while 1 and 6 are longer and subequal.

Length, 2·1 mm.; alar expense, 3·75 mm.

S.W. Persia: Ispahan, 1 ♀ (*M. M. Escalera*, Brit. Mus.).

P. illustris somewhat resembles *P. eubius*, Walker (*Entedon eubius*, Walker, Mon. Chalcid., i, p. 109, 1839), but it is a smaller insect, differing slightly in the abdomen and legs. Walker also describes a *Pleurotropis obscurella* from the Amur (Cist. Ent. i, pt. 2, p. 320, 1874), which appears to be a true *Pleurotropis*, and, according to the author, it comes near *P. eubius* and *P. caenus*. The wings are "cinereous," so that the species would probably separate off at the beginning of the table with *P. clinognathus*. *P. obscurella* has probably the inner edge of the mandible serrate.

Genus Syntomosphyrum, Förster.

Dr. G. D. H. Carpenter has forwarded for determination from Uganda a small Eulophid which I have had difficulty in placing. The species falls into the fifth tribe, Tetrastichini, of Ashmead's scheme, belonging there to the group which lacks the central longitudinal impressed line on the mid lobe of the mesonotum. Of the genera so characterised three only are in question, viz.:—*Syntomosphyrum*, Först., (Verh. d. naturh. Ver. pr. Rheinl., xxv, p. 60, 1878), *Trichaporus*, Först. (Hym. Stud., ii, p. 84, 1856), and *Tetrastichodes*, Ashm. (Mem. Carneg. Mus., i, no. 4, p. 349, 1904).

Trichaporus, as defined by Förster, had no genotype assigned to it, but Ashmead (1904) employed the name in describing three new species from Brazil, placing these at the same time with *Exurus colliguayae*, Philippi (Stett. Ent. Zeit., xxxiv, p. 296, 1873), and rejecting Philippi's genus as a synonym. The African insects are, I believe, generically distinct from the S. American forms, and Dr. R. C. L. Perkins, to whose kindness in looking at some preparations I am much indebted, writes that they have nothing to do with *Trichaporus* as he understands the genus.

Syntomosphyrum, Först., and *Tetrastichodes*, Ashm., are probably best separated by the scutellar characters, as there is considerable variation in the antennae. I have not been able to find any full definition of Ashmead's genus, but the two species examined (types) show two sharp median impressed lines (besides the lateral sulci separating the dorsal surface from the sides) on the scutellum. Of his *Syntomosphyrum*, Förster distinctly says: "Das Schildchen hat keine längsfurchen," referring, I take it, to the area *within* the lateral furrows. To this description, the type of *Syntomosphyrum insulare*, Ashm. (Journ. Linn. Soc. Lond. Zool., xxv, p. 181, 1894), from the West Indies, which I have examined, and *S. indicum*, Silvestri (Boll. Lab. Zool. Portici, iv, p. 228–245, 1910), appear to conform. I have accordingly referred the African examples to the same genus. As regards the condition of the scutellum in the West Indian species, I do not feel completely satisfied. *S. insulare*, Ashm., is a very black form, and the fine lines, even if present,

might be demonstrable only in a cleared and mounted specimen. Ashmead (*loc. cit.*) speaks of the scutellum as "smooth, without distinct grooved lines, rarely slightly indicated at the extreme base." Later, he ascribed to *Syntomosphyrum* four scutellar furrows in defining the genus (Mem. Carneg. Mus., i, p. 350, 1904), which is not in accord with Förster's definition. Ashmead's redefinition, however, seems to have gained some acceptance, for Girault (Mem. Queensld. Mus., ii, p. 205, 1913) treats *Neotetrastichus*, Perkins (1912), as a synonym of *Syntomosphyrum*, Först. This can hardly be correct, as Perkins' genus has two central impressed lines on the scutellum.

Syntomosphyrum glossinae, sp. nov. (figs. 14–16).

A species characterised by the bluish black head and thorax, the pale legs, the slightly tinted anterior wings, and the lighter-coloured median basal portion of the abdomen of the ♀. Length, 1·25 mm. (♂), 1·4–1·6 mm. (♀). Alar expanse, 2·3 mm. (♂), 2·5–2·6 mm. (♀).

Fig. 14. *Syntomosphyrum glossinae*, sp. n., ♀.

♀.—*Head*, seen from in front, triangular, the occiput sharply defined, very concave behind and slightly so on the frons; reticulate, with hardly any reflections, colour bluish black. Eye large, dark red, bare, but under high magnification (× 600) one or two minute scattered hairs may be detected; greatest diameter less than one-third of the entire face. Scrobes set on the base line of the eyes, rounded oval, outwardly slightly flattened. Malar space distinct; clypeus with two slight furrows outside the scrobes, curving towards one another,

not reaching the mouth edge, which is bilobed ; these lobes of the clypeus bear each three bristles, and there are about a dozen, in four rows of three, between the mouth edge and the line of the scrobes.

Mouth-parts: mandibles tridentate (fig. 15, *d*), outer tooth sharp and somewhat deeply separated from the inner pair, which are smaller ; inner edge of mandible swollen, then contracted. Trophi normal ; both maxillary and labial palpi one-jointed. The stipes with one hair before the base of the palpus. Maxillary palpus long, with four bristles, two subapical and two apical, the latter stouter, one of them (the inner) shorter. The labial palpus bears a single terminal bristle, and there is one hair on the mentum between the palpi.

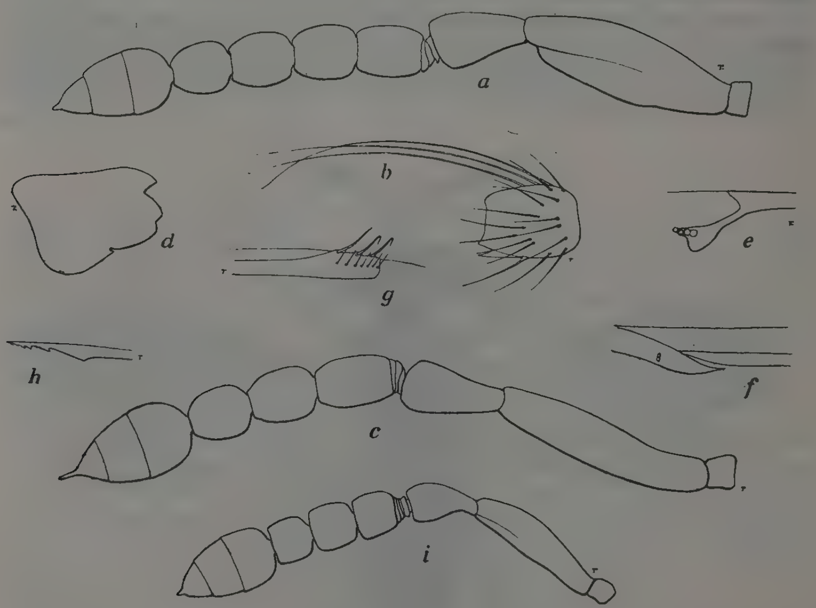

Fig. 15. *Syntomosphyrum glossinae*, sp. n. ; *a*, antenna of ♂ ; *b*, 3rd funicular joint of ♂ (outer side) ; *c*, antenna of ♀ ; *d*, mandible ; *e*, radius of ♀ ; *f*, junction of submarginal and marginal veins ; *g*, end of marginal vein of hind wing in ♀ ; *h*, apex of ovipositor ; *i*, antenna of *Syntom. phaeosoma*, sp. n.

Antennae eleven-jointed (fig. 15, *c*) : scape, pedicel, three ring joints, three funicular joints and three to the club ; ·62 mm. in length. Scape barely one-third of the antennae, slender, four-and-a-half times as long as broad, pale, clothed all over its outer surface with equal short hairs ; pedicel barely one-half the scape, long, slightly broader than the scape distally, and a little darker in colour, with about 20 coarser bristles ; the second ring joint wedge-shaped in profile. Funicle with diminishing joints (30, 27, 25), the first being cylindrical, and the second and third more bead-like. The club distinctly broader than the funicle, twice as long as broad,

segmented in the proportion of 4:3:3; the apical joint with a spur. In no region is the antenna really black, but the funicle and club are dusky. After the ring joints all the joints bear both hairs and sensory channels surmounted by clear, triangular, chitinous flanges.

Thorax black with bluish and even slightly greenish reflections, except on the pronotum, where there is a purplish tinge. *Pronotum* narrow antero-posteriorly and descending roundly towards the occiput and neck, neither elongated anteriorly nor sharply ridged transversely. The whole surface is reticulate, delicately so from the neck to the posterior edge, the pattern becoming coarser towards the sides and reaching its maximum on the pleural flap enveloping the pre-episternite. One strong short bristle above the spiracle on each side, and between these a transverse row of similar bristles (twelve in all), the median pair stronger than the others; the general surface of the pronotum in front of this row with numerous minute hairs, 60 to 70 in all. *Mesonotum* (fig. 16) with the parapsidal furrows complete, straight, wide, deep; two widely separated parallel lateral furrows on the scutellum. No furrow on the mid lobe of the mesonotum, but the mid line in a cleared specimen indefinitely paler. Axillae sharply and extensively produced into the parapsides or lateral lobes. Entire surface evenly reticulate, the pattern being coarser only at the outer edge of the mid lobe. The latter bare on the anterior quarter, with over 30 short bristles behind and one strong bristle before the postero-lateral angle. Lateral lobes with one strong bristle at the postero-lateral angle before the tegula, and some 15 others on the surface. Axillae bare. Scutellum with the lateral lines well-marked, mid lobe with two parallel rows (3, 3) of clear pustules, the first and third setigerous; outer lobes bare. *Metanotum* distinctly developed in three surfaces, viz.:—two smooth and depressed at the sides, with a median broadly pentagonal reticulate area, separated from the sides by ridges. *Propodaeum* well developed, oblong, with straight posterior edge and distinct lateral angles, which do not project beyond the line connecting them and passing through the insertion of the petiole. Apparently flat from above, but really declivous on the posterior quarter and towards the sides from the sharply defined central keel. There is no lateral keel or ridge except near the extreme side, where there is an abrupt descent of the pleura to the insertion of the coxa. The spiracle lies at the anterior angle of the dorsum. The entire upper surface of the propodaeum is bare and reticulate; on the pleurae, above the metacoxae, are three short bristles. The most distinct character of the propodaeum as a whole is that the anterior and posterior and the lateral edges respectively are parallel, save where the posterior edge is excavated for the petiole. The *sternum* of the thorax reticulate; the mesosternum somewhat quadrate with a central ridge; bare; mesopleurae furrowed; mesoprepectus large, triangular, reticulate; sternite divided by a ridge into an upper smooth and a ventral reticulate portion; epimeron bare.

Wings: fore wings long and narrow (20 : 7), shortly ciliated at the edges, widest at a point well beyond the radius. Submarginal a little shorter than the marginal (5 : 6), with only a trace of the postmarginal; radius moderate, with four cells (fig. 15, *e*); both marginal and submarginal veins broad and the former only narrowly interrupted; the marginal vein bears seven to eight stout bristles. The whole wing has a faint transparent brown tint. Length, 1 mm.; breadth, ·35 mm. Hind wings

long and narrow almost as long as the fore wings; apically much rounded, with fairly long posterior ciliation. Submarginal two-thirds of marginal. Length, ·9 mm.; breadth, ·2 mm.

Abdomen sessile, ovate, terminally pointed, the segments subequal. The extreme base and the sides narrowly to beyond a half, dark, there being a central clear area, broadest on segments 2 and 3. Anal tergite with sessile stylets, giving rise to three long and one short bristle; in front of the stylets the tergite has a row of four to five bristles, and behind them (but mainly within lines drawn posteriorly from the stylets) are sixteen to seventeen bristles; many bristles on the tergite outside the stylets. The sheath of the ovipositor sparingly set with bristles, there being about six on the free distal portion; the saw is here longer than the supporting blades, with several teeth at somewhat long intervals; the free portion of sheath one-third of the base; the tip of the ovipositor (fig. 15. *h*) and the extreme base dark, the rest pale.

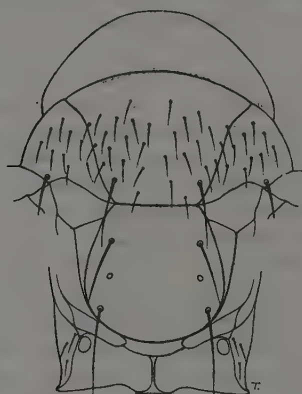

Fig. 16. *Syntomosphyrum glossinae*, sp. n., ♀; chaetotaxy of mesonotum.

Legs concolorous pale yellowish, only the claws darker; their broader surfaces, *e.g.*, on the coxae and femora, more or less faintly reticulate. *Fore legs* with the coxa pear-shaped, twice as long as broad, with six to seven minute bristles on outer ventral aspect. Femur moderately swollen, nearly thrice as long as broad; both surfaces with numerous minute bristles, and a row of twelve to fourteen on the dorsal edge; the ventral edge bare, save for three to four short bristles near the base; the subapical subventral posterior bristle dark and fairly strong. Tibia very slightly longer than the femur, covered sparsely but evenly with bristles on both sides, and with rows on both edges, two apical ventral bristles and a transverse row (seven) of short hyaline spines on outer aspect. Tarsal joints—17 : 24 : 19 : 30; first joint depressed, thinner on the outer edge, where are seven single bristles on the inferior edge, with two much stronger ones apically; on inner ventral edge about four pairs of stronger bristles; joints 2 to 4 neither depressed nor inequilaterally thinned, with several short bristles on dorsal surface, and three to four (singles or doubles) on ventral aspect. *Mid legs* with the coxae quadrate, longer than broad (4 : 3), with a strong longitudinal

median keel; the apex obliquely truncate from about two-thirds along the posterior edge to the insertion of the femur; two bristles on the keel and one at the apex, also three to four short ventral bristles. Femur with one or two basal ventral hairs and thence from base to apex nearly twenty short bristles along the dorsal edge, and several others on surface near the edge, especially towards the upper apical angle; the rest of the femur bare, except for the usual subapical bristle. Tibia distinctly longer than the femur (5 : 4), covered with short bristles; one long, ragged bristle at apex continuing the line of the tibia, in length three-tenths of the tibia itself, or three-quarters of the first tarsal joint. The tarsus is nearly equal to the tibia, the proportions of the joints being, 60 : 35 : 25 : 30. *Hind legs* with the coxa long, pear-shaped (17 : 10); on the inner surface near apex two fine bristles, a stronger one on the upper surface at about the same position, two apical bristles and one to two ventral. Femur shorter than tibia; nine to ten ventral or subventral bristles and a closer row on dorsal edge; about a dozen others, mainly on outer apical surface. Tibia densely clothed with bristles; the subapical spine strong, equal to two-thirds of the first tarsal joint. Tarsus—40 : 34 : 25 : 33.

♂.—*Head* in general shape like that of the ♀, but broader across the frons; eye bare, not much over one-fifth of the face; scrobes more flattened on outer side, whole face much broader than deep. Between the anterior ocelli and scrobes about thirty short hairs, distributed equally about the mid line; one or two near the eye, longer, and forming a fairly regular orbital row; on vertex two to three stronger bristles, there being two also on the occiput and three on the ocellar area.

Mouth-parts: labial palpus with two distinct bristles. Stipes with one small bristle on each side of mid line in addition to the stronger one near the palpus. Lingua with four hairs from raised cells.

Antennae twelve-jointed (fig. 15, *a*): scape, pedicel, three ring joints, funicle four, club three. Scape, length to breadth, 8 : 3; swollen sides not subparallel; subapical ventral bristle stronger than the others. Pedicel one-half the scape; length to breadth, 2 : 1; with very strong bristles, five being really spines. The four joints of the funicle are subequal in diameter, but the first pair appear larger, being cylindrical, while the second pair are more bead-like, the angles being rounded off; the joints bear on the upper surface long tubular hairs (from five to three), besides the usual hairs (which are stronger than in the ♀) and sensory channels with triangular spurs (fig 15, *b*); these channels are not developed on the lower surface. Club joints in the proportion, 15 : 17 : 6; the first with long hairs like the funicle. Length of antenna, ·64 mm.

Wings: fore wing, 1 mm. long, ·44 mm. broad. Submarginal : marginal : radius—4 : 4 : 1; the marginal broad, the post-marginal obsolescent; the radius as in the ♀, with four cells, with a relatively larger more quadrate termination. Hind wing, ·9 mm. long, ·2 mm. broad. Below the hooks and on the vein ending are six minute straight bristles.

Thorax as in the ♀, the mesonotum bears at the posterior end of the mid ridge one bristle on each side and one at the postero-lateral angle; the tegulae also in both bear a strong and a weak bristle; mid lobe of mesonotum with only twenty-five bristles before the two strong posterior ones. Metanotum with the sunken side-pieces obscurely reticulate, not smooth as in the ♀; both sexes with one minute hair near

the middle of the anterior edge of this sclerite. Propodaeum with a minute hair before the postero-lateral angle (possibly not in ♀), no trace anteriorly of ridge separating notum from pleura; the sides posteriorly more convergent than in the ♀, and the postero-lateral angles more defined; the posterior edge more undulated.

Abdomen almost entirely dark, with only an obscurely lighter medio-basal area. Segments subequal. In the abdominal chaetotaxy the sexes are similar, the bristles or hairs being dispersed in lateral patches about the mid line; on tergites 4 and 5 they tend to form regular rows; on tergites 2 to 4 the ♂ is slightly more setose. On each side off the mid line there are bristles as follows:—Tergite 1, 7 to 8; T. 2, 8 to 10; T. 3, 9 to 11; T. 4, 14 to 17; T. 5, 20 to 21; T. 6, 12 to 13. In the ♀ tergite 7 bears seven bristles outside the stylet and about fifteen between the stylets; in the ♂ the bristles, both outside and inside, are more numerous.

Legs: fore legs with ten to eleven short bristles on outer side of the coxae; femur more swollen than in the ♀; tarsal joints—15 : 20 : 18 : 26. Mid legs with the apical spine of the tibia much frayed; first tarsal joint with half-a-dozen longish hairs beneath; tarsal joints—45 : 25 : 20 : 30. Hind legs with the tarsal joints as, 30 : 28 : 20 : 33.

Uganda: Wema Island, Victoria Nyanza, 2 ♂♂ and 6 ♀♀, bred from puparium of *Glossina palpalis*, R.D. (*Dr. G. D. H. Carpenter*).

Holotype—a ♀.

Syntomosphyrum phaeosoma, sp. nov. (fig. 15).

♀.—Similar to *S. glossinae*, sp. n., but smaller, with shorter and more compact antennae. In general less shining and with an entirely opaque abdomen. As in *S. glossinae*, the base of the abdomen is smooth (to about the middle of tergite 3), but the succeeding tergites are considerably roughened (raised reticulate). The most appreciable differences, however, are in the antennae (see fig. 15, *i*).

Length, nearly 1·3 mm.; alar expanse, nearly 2·25 mm.

Northern Nigeria: 1 ♀ bred with *Pleurotropis amaurocoela*, sp. n., from the cocoon of a Braconid (*Apanteles* sp.) parasitic on the leaf-roller of cotton (*Sylepta derogata*, F.), 18.ix.13 (*Thos. Thornton*).

Genus Tetrastichus, Haliday.

The species described below belongs to the section of the genus which has an elongated, almost *Hyperteles*-like abdomen. In general build it resembles *T. brasiliensis*, Ashm. (Mem. Carneg. Mus., i, p. 515, pl. xxxix, fig. 2), but differs in size, colour, etc.

Tetrastichus melichlorus, sp. nov. (fig. 17).

A yellowish or tawny species, with dark head and dusky antennae; prothorax and nearly all of the mesothorax dark, as are also the tip and mid region of the abdomen. The propodeal spiracle lies in a dark patch and the caudal spiracle likewise is outlined in black. The legs are clear honey-yellow, the hind coxae large and coarsely shagreened.

♀.—*Head* longer than deep (5 : 4). Vertex and frons reticulate, with many bristles, about eight on the occipital edge, with a number below on the occiput itself; three

on each side at the orbits and about 16, short, stout and spinose, on the ocellar triangle; on each frontal plate from the upper suture to the scrobes are about a dozen bristles, placed mainly near the orbits. Scrobes rather large, oval, just above the base line of the eyes; a distinct keel from the clypeal corner to the lower angle of the eye, with nine to ten short bristles inside, on the frontal aspect.

Antennae 11-jointed (fig. 17, *a*): scape, pedicel, three ring joints, funicle of three, club of three. Length, 1 mm.; long, cylindrical and not expanded in the club. The scape is flavescent, and the other joints (except the ring joints) brownish and infuscated; the pedicel a little flavescent below. Scape three-and-a-half times as long as broad, with one strong subapical ventral bristle, and two to three behind on the same line. Pedicel not half the length of the scape, longer then broad (8 : 5). Three ring joints, the basal one with a broad articulation, the others more leaf-like, but apparently distinct. Funicle joints cylindrical and elongate, about twice as long as broad, and subequal; the middle one a trifle longer than the first or the third, each bearing about 12 sensoria with strong processes. Club joints in the proportions 9 : 8 : 6; the third joint tapered into a stout spur, on which stands a minute bristle; the sensoria well developed.

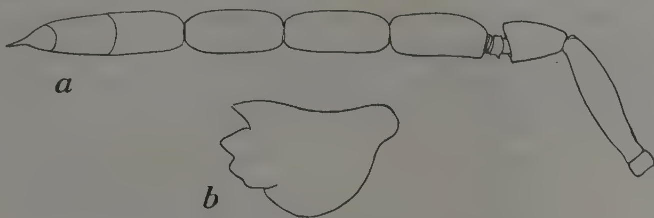

Fig. 17. *Tetrastichus melichlorus*, sp. n.; *a*, antenna; *b*, mandible.

Mouth-parts: the cardo boot-shaped, the heel rounded off, and the stipes large. The maxillary palpus four to five times as long as the labial, with one post-median outer hair, two (a shorter and a longer) subapical, and exactly at the apex, a thick truncated hyaline bristle. Galea with four or five of the stronger bristles rising from cells. Mentum with a single, rather long bristle well behind the base of the palpi. Lingua with four setigerous marginal cells. Mandibles (fig. 17, *b*) with three teeth, the outer (ventral) pair rather deeply separated and of equal length, the innermost marked off by a shallow concavity and with rounded apex; behind the third tooth the mandible swells out, but contracts at the middle of the inner edge, being again slightly swollen on the same edge near the base.

Thorax longer than broad (3:2). *Pronotum* entirely brownish black, with a posterior row of eight to ten bristles, and many in front. *Mesonotum* yellowish, with a distinct brown blotch extending from the base four-sevenths towards the apex; apically the blotch is a little incised medianly, and at the sides near the parapsidal furrows there is a narrow, indefinitely paler margin; along this margin are placed six hairs, and a stronger bristle near the apical corner. The median furrow is broad, and completely interrupts the moderately coarse, even reticulation of the lobe.

Parapsides with still coarser (but hardly raised) reticulation, deeply invaded by the narrow, finely striate reticulate axillae, and provided with seven to eight bristles, that above the tegulae being stout. *Scutellum* yellow, with browner tinge posteriorly; a little broader than long (10 : 9), with four wide deep sulci, which divide the width in the ratio 3 : 4 : 3; evenly striately reticulate; each dorsal side-piece bears two bristles, and there is another posteriorly above the metathorax. *Metanotum* narrow, mid lobe reticulate, side-pieces rugulose. Propodaeum with strong keel and much raised; pale, darker round and below the stigma, which is shortly oval or nearly round, with two bristles below.

Wings: fore wing not quite three times as long as broad; 1·8 mm. long, ·7 mm. broad. Submarginal cell narrow, with six bristles on the distal third, and four on the basal third, the mid third bare; submarginal vein with five to six bristles; the inner edge along the marginal vein with 13 to 14 fringing bristles; six on the radius. Submarginal : marginal : radius—3 : 6 : 1; the radius rather long and apically gradually expanded. Hind wing, 1·3 mm. long, ·3 mm. broad.

Legs: *fore legs* entirely pale, a little tinged with brown on the inner sides of the coxae; the sternum and episternum still darker. Coxae coarsely reticulate, with about 15 bristles evenly distributed on the surface, one (subapical) being longer and stouter. Femur not swollen; on the basal two-thirds a ventral row of five bristles, and about two others on the outer surface. Tibia longer than femur; apical transverse comb of six spines. First tarsal joint with a row of 10 to 12 short spines on the inside; proportions of joints—35 : 38 : 35 : 45. *Mid legs* long and slender; entirely pale; coxae with three bristles only. Tibiae much longer than femora. Proportions of tarsal joints—60 : 50 : 40. Tibial spine five-sixths of first tarsal joint. *Hind legs* with the coxae large, swollen, superiorly very coarsely reticulate, bare exteriorly, save for the subapical median bristle. The femur bears about twelve external bristles. The tibial spur is strong and equals the first tarsal joint, and there is a transverse row of seven to eight spines.

Abdomen with the peduncle broad; second tergite pale, third dark at sides, fourth and fifth entirely darkened, sixth with an anterior dark band produced medianly behind and two paler spots at the sides. Spiracles very small, circular, set in a brown spot. All the tergal surface, from the fourth to the seventh, coarsely reticulate and raised; second tergite smooth, third reticulate at sides. The second tergite has two to three bristles at the side, the third five to six, the fourth and fifth eight to nine and seven to eight respectively, with a few in front; the sixth has 15 to 17 in a patch on each side, and a transverse posterior row of seven bristles; the seventh tergite bears on each side, mainly behind the spiracles, about 16 bristles. The tergites increase in length gradually, 2 to 5 being subequal, and 6 considerably longer. The eighth tergite long and conical, densely covered with spiny bristles, with the stylets distally placed. Stylet short with swollen base, three short and one long bristle. The ninth tergite articulated considerably behind the apex of the eighth; free portion to base as 3 : 5. The free flaps are brownish yellow, with a broad subapical dark band and a light spot on the apex.

Length, over 2·75 mm.; alar expanse, over 3 mm.

H. GOLD COAST: Aburi, 4 ♀♀ (*W. ~~A~~. Patterson*).

A NEW ANOPHELINE MOSQUITO FROM SUMATRA.

By A. T. Stanton,
Institute for Medical Research, Kuala Lumpur,
Federated Malay States.

In the course of an investigation of malaria in the Lampongs, a district of South Sumatra, in the months of May and June 1914, Dr. Schüffner captured a large number of Anopheline mosquitos, among them a series of specimens of a species which he recognised as new to Sumatra.

The larva of this mosquito has not yet been identified; should it prove on examination that it is of the *fuliginosus* type, I should prefer to regard the mosquito here described as a variety of that species. From the characters of the adult insect, however, I think the larva will be found to be clearly distinct, and I have assigned the name, *schüffneri*, to the species in honour of its discoverer.

The following description has been drawn up from an examination of six females, no male of the species having so far been taken.

Anopheles schüffneri, sp. nov.

A small dark mosquito. Palpi with three white bands, two of them narrow and one broad apical band. Scutum with broad elliptical scales. Wing costa with four yellowish spots. Hind legs with two and a half tarsal segments white. *Length,* including proboscis, 4·5 mm.

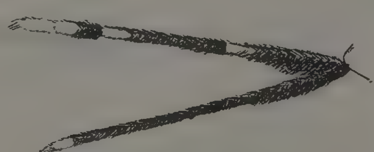

Fig. 1. Palp and proboscis of *Anopheles schüffneri,* sp. n., ♀.

Head.—The usual upright forked scales clothe the vertex; in the mid line anteriorly these scales are white, elsewhere they are black. *Palps* (fig. 1) with dark brown scaling; a narrow white band at the distal end of segments 1 and 2; the distal half of segment 3 and the whole of segment 4 white. The apical white area is three times the length of the next succeeding dark area. Lengths of palpal segments: 1, 0·45 mm.; 2, 0·45 mm.; 3, 0·20 mm.; 4, 0·12 mm. *Proboscis* with dark brown scaling, and golden yellow at the tip.

Antennae with a few small appressed scales on segment 2; segments 3 and 4 with long outstanding scales.

Thorax.—The scutum carries numerous broad elliptical white scales and long brown hairs, and on its anterior edge in the mid line some long narrow

white scales. Scutellum with long bristles and broad scales as on the scutum. Prothoracic lobes carrying a few hairs, and without scales.

Wings.—The costal vein is clothed with dark brown scales interrupted by four yellowish spots. The wing field is in general sparsely clad with yellowish scales. Brown spots are distributed as follows: on the auxiliary or subcostal vein, two; on the first vein, four; on the stem of the second vein, one; on its anterior branch, one; on its posterior branch, two; on the third vein, which is for the most part light-scaled, three small dark spots; on the stem of the fourth vein, two; on its anterior branch, two; on its posterior branch, one; on the fifth vein near its origin, one small dark spot, the rest of the stem light-scaled; on its anterior branch, three dark spots; on its posterior branch, one or two dark scales near the fork and a dark spot at the wing margin; and on the sixth vein, three dark spots. There is a yellow apical fringe spot and a yellow spot on the wing fringe opposite the termination of each long vein.

I have here described the appearance of the upper surface of the wing in the female. It is recognised that these characters do not possess the specific value formerly assigned to them, as not only do they differ on the two surfaces of the same wing but also on the same wing surface in the male and female of certain species.

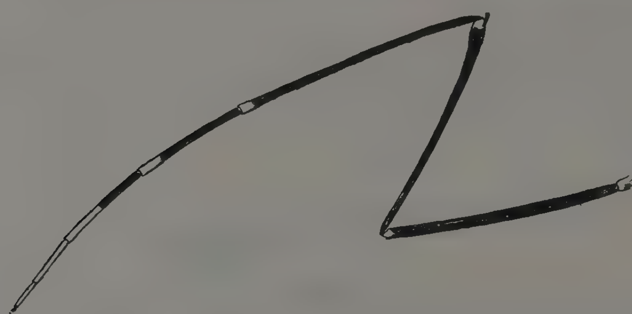

Fig. 2. Hind leg of *Anopheles schüffneri*, sp. n., ♀.

Legs with dark brown scaling, unspeckled, with white bands as follows: on the front pair, a narrow band at the distal end of the tibia, broad bands at the distal ends of tarsal segments 1, 2 and 3, a narrow band at the distal end of tarsal segment 4; on the middle pair, narrow bands at the distal ends of the tibia and tarsal segments 1, 2, 3 and 4; on the hind legs (fig. 2), narrow bands at the distal ends of the tibia and tarsal segment 1, at the distal end of tarsal segment 2 a broad band, equal to one-fifth the length of the segment, the distal half of tarsal segment 3 and the whole of tarsal segments 4 and 5 white.

Abdomen.—Segments 1 to 7 with long brown hairs only. On the posterior edge of segment 8 above and below there are a few broad scales, and on the genital lobes there are numerous broad dark brown and yellow scales.

The only species hitherto recorded from the Malay Peninsula or adjacent islands which bears any resemblance to the mosquito described above is *fuliginosus*,

Giles, from which the new species differs in the markings of the palps and wings and conspicuously in the abdominal scaling and markings of the hind legs. Two varieties of *fuliginosus* have been recorded from India—namely, var. *adei*, James and Liston, and var. *nagpori*, James and Liston. I have compared the new species in detail with specimens of these varieties; it is clearly distinct from them in the wing, palp and leg markings and in the abdominal scaling.

Other species described as having more than two and less than three hind tarsal segments white and bearing broad elliptical scales on the thorax, are the African species *pretoriensis*, Theo., the Arabian species *tibani*, Patton, and the Indian species *theobaldi*, Giles; but all these have speckled legs.

The new species appears to resemble in some of its markings the African *rufipes*, Gough, first referred to under the name *pretoriensis*, var. *rufipes* (Transvaal Dept. Agric., Rept. Gov. Vet. Bact., p. 119, 1910), and later described by Edwards under the name *Anopheles* (*Nyssorhynchus*) *watsoni* (Bull. Ent. Res., ii, p. 143, 1911). With reference to this species Edwards notes that "there are no scales on the abdomen of the female." In this character and in the markings of the legs the new species differs from *rufipes*, and these characters are constant in the small number of specimens examined.

The accompanying drawings have been made for me by Mr. R. W. Blair.

SOME INJURIOUS INDIAN WEEVILS (CURCULIONIDAE).

By Guy A. K. Marshall.

Phytoscaphus dissimilis, sp. nov.

Colour black, with greyish brown scaling; the prothorax with a broad ill-defined darker stripe on each side; the elytra with a conspicuous white spot at the base of the suture, and an oblique whitish stripe about the middle, with vague and variable dark brown patches on each side of it.

Fig. 1. *Phytoscaphus dissimilis,* sp. n.

Head more deeply immersed in the prothorax than usual, the forehead with a central stria and hardly narrower than the eyes, which are almost plane. *Rostrum* stout, the apex moderately dilated, the upper surface plane in the basal half, but anteriorly with a sharp central carina and a deep impression on each side of it, the scrobes deep and extending more than half-way to the eye, the upper lateral furrow deep, the lower absent, the under surface without a basal impression. *Antennae* with the scape gradually clavate and with a row of stiff bristles on the convex edge; the funicle with the two basal joints subequal, 3 to 7 not longer than broad, and 7 shorter than the first joint of the club. *Prothorax* as long as broad, the sides rounded, broadest before the middle, the base perfectly straight and not broader than the apex, the ocular lobes strongly developed, broadly rounded and without vibrissae, the upper surface with coarse punctation visible through the scaling. *Elytra* truncate at the base, the sides slightly dilated from the shoulder to behind the middle, the apices jointly rounded, the dorsal outline regularly convex, the setae stout, erect and spatulate. *Legs* with the anterior tibiae bisinuate internally, but without a distinct angulation, the corbels of the posterior tibiae open.

Length, $3\frac{1}{2}$–4 mm.; width, $1\frac{1}{2}$–$1\frac{3}{4}$ mm.

Assam: Patkai Hills and Sadiya (*W. Doherty*); Silonibari, N. Lakhimpur (*H. Stevens*).

Mr. Stevens notes that he has found this weevil nibbling the young shoots on tea bushes.

Corigetus bidentulus, Fst.

Mr. H. Stevens records this species as a serious pest of tea at Silonobari, Assam, but nothing is known as to its life-history.

The general appearance of the insect is shown in the accompanying figure (fig. 2). The upper side colouring varies from greyish brown to dark brown, with a

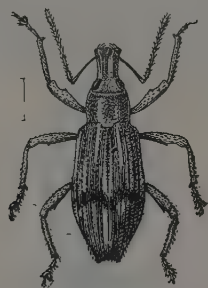

Fig. 2. *Corigetus bidentulus,* Fst.

very irregular and variable brownish black band behind the middle, the lighter markings being pale metallic green. The lower surface is usually grey with a sprinkling of metallic green scales, but may be either entirely grey or entirely green.

Assam: Silonibari, N. Lakhimpur (*H. Stevens*); Naga Hills, Patkai Hills and Manipur (*W. Doherty*). Burma: Bhamo and Teinzo (*L. Fea*).

Rhynchaenus (Orchestes) mangiferae, sp. nov.

Light reddish yellow, the elytra rather darker round the scutellum, along the suture and along the lateral margin; thinly clothed with recumbent white hairs,

Fig. 3. *Rhynchaenus mangiferae,* sp. n.

with a few black ones interspersed, the white hairs rather thinner in places, giving the appearance of faint banding.

Head with the eyes separated by a very narrow line covered with white hairs and with a band of elongate white scales below the eyes. *Rostrum* rather short, about

as long as the prothorax, almost straight, very shiny and sparsely punctate, the base clothed with white hairs. *Antennae* inserted quite close to the base of the rostrum, the scape strongly clavate and short, about as long as the first two funicular joints; the funicle 6-jointed, joint 1 much longer and stouter than any of the others and clavate, 2 and 3 subequal and longer than broad, the remainder becoming shorter and more transverse; the club ovate, the apex blunt. *Prothorax* transverse, broadest at the base and strongly narrowed anteriorly, the sides quite straight and without any apical constriction, the basal margin roundly produced in the centre, the upper surface rather coarsely punctate throughout. *Scutellum* with a few white hairs. *Elytra* oval, the sides regular rounded, the shoulders very oblique, broadest before the middle, the apices separately rounded; shallowly striate, the striae indistinctly punctate, the intervals scarcely convex, coriaceous and shiny; the white hairs so sparse as hardly to conceal the integument, the black ones arranged for the most part in two rows on each interval. *Legs* pale yellow, thinly clothed with white hairs, the posterior femora very large, their lower edge armed with two distant small black spines, and beside these a row of 6 to 9 very minute black spines, the posterior tibiae with a horseshoe-shaped comb of black teeth at the apex.

Length, $1\frac{3}{4}$–2 mm.; *width*, $\frac{7}{8}$–1 mm.

MADRAS: Guntur, Godavari, Kistna.

The specimens before me (from Guntur) have all been bred, and it seems possible that the colouring of the elytra is not fully developed; it is probably darker in normal specimens.

The larvae of this beetle bore in the leaves of the mango tree, and an account of their life-history has already been published by Mr. T. Bainbrigge Fletcher ("Some South Indian Insects," p. 334, 1914). He says that the insect is "a minor pest of local importance. As many as 20–30 larvae may be found in one leaf and such leaves . . . . dry up completely; in such cases a good deal of damage may be done. The beetles also may cut small holes in the leaves, but the damage thus done is inconsiderable."

Pachytychius mungonis, sp. nov.

Pitch-brown, the prothorax with dark brown scales, some of which are paler towards the sides, and with a narrow central stripe of whitish scales; the elytra with fairly dense light brown scaling and with large confluent patches of creamy white scales, except on the first two intervals.

Head deeply set in the prothorax, and closely and coarsely punctate throughout. *Rostrum* moderately stout and strongly curved, with six closely punctate deep sulci, the external ones being much broader than the others in the basal half, the intervals convex, smooth and shiny, with occasional isolated punctures; in the ♂ both the internal and external pairs of sulci reach the apex, the intermediate pair only reaching the antennae; in the ♀ the internal pair of sulci scarcely reach the antennae, being continued to the apex in the form of a row of punctures. *Prothorax* much broader than long, the sides moderately rounded, broadest in front of the middle, abruptly narrowed and slightly constricted at the apex, the basal margin shallowly bisinuate; the dorsal surface very closely and evenly punctate throughout, but sometimes with

an abbreviated smooth central line. *Elytra* oblong-ovate, the sides parallel from the shoulder to well beyond the middle, the basal margin jointly sinuate; deeply striate, the striae containing large elongate punctures and becoming much broader and deeper at the apex, the intervals broad, plane and transversely wrinkled; the

Fig. 4. *Pachytychius mungonis*, sp. n.

scales are relatively large and oblong, and where they are dense the striae appear as narrow lines with hardly any trace of the punctures. *Legs* rather stout and fairly closely covered with pale scales, all the tibiae sinuate at the base, the posterior pair bluntly angulate internally near the middle.

Length, 4–5½ mm.; width, 1¾–2¼ mm.

MADRAS: Bellary, Kurnul.

This species is a pest of green gram, and Mr. T. Bainbrigge Fletcher gives the following information concerning it: "The eggs are laid in a hole bored in a seed of green gram (*Phaseolus mungo*) or cow-pea, the female having previously eaten her way inside the pod. Three eggs are usually laid in one pod, one at each end and the third in the middle of the pod. The grub on hatching feeds on the seed, devouring three or four seeds before it is full-fed, when it emerges from the pod and drops to the ground in which it pupates. A local pest, which may at times do considerable damage. Said to occur more commonly on areas of black cotton soil." ("Some South Indian Insects," p. 336, 1914.)

OBSERVATIONS ON GLOSSINA MORSITANS IN NORTHERN RHODESIA.

The British South Africa Company have recently received a report from Mr. R. A. F. Eminson, one of the three Entomologists whom they have engaged for the special study of the bionomics of *Glossina morsitans* in Northern Rhodesia, upon the work done by him from May to July, 1914.

In the course of his remarks on breeding places Mr. Eminson states that he has not yet succeeded in ascertaining definitely why certain spots are specially preferred by *G. morsitans* for breeding purposes; but two negative points are noted, namely, that in country otherwise suitable, no favoured breeding places have been found in any localities in which there was any depth of sandy soil, or in which there was a dense growth of long grass. Although a search was made for pupae over a considerable area, the great majority were found within a comparatively restricted space. This favoured area is described as being "uniformly covered with forest trees; very little grass grows amongst the trees, and that little is short; the soil is of a sandy gravelly nature and very thin, merely covering the underlying granite which crops out in places. The surface of the ground shows a gentle slope in a north-westerly direction to a vlei [open, moist, low-lying land] in which a little water stands in the wet season, but which is completely dry at this season [mid-winter]. I cannot say that I have noticed much spoor of game, except some impala and wart-hog; certainly I should not say that there was any more game than in the surrounding country, if as much. The breeding places which yielded the greatest number of pupae and empty pupa-cases were situated near the path; the fly had evidently been feeding on game, or more probably human beings, preparatory to depositing their larvae."

It is noted that many of the logs under which large numbers of pupae were found were devoid of bark, and in Mr. Eminson's opinion, the female tsetses prefer a smooth barkless log on which to rest before depositing their larvae. They also show a preference for a log which in some part of its length is raised a few inches above the ground, thus affording a shady resting place; a point which has already been emphasised by Mr. Llewellyn Lloyd.

An account is given of some experiments in feeding captive flies on avian blood only, but the results are vitiated by the fact that the insects were kept in cages which were clearly unsuitable. In any case, laboratory experiments of this kind can never be regarded as entirely satisfactory.

A much safer method of arriving at the normal food of *Glossina* is by an examination of the gut contents of captured flies in various conditions of environment. During May 1914, 300 flies were examined for this purpose, and recognisable blood was found in 43; of these, 41 contained mammalian and 2 non-mammalian blood, so that the latter amounted to 5 per cent. It is stated that a similar investigation during the wet season months of February and March yielded only 1 per cent. of flies containing non-mammalian blood, but the actual numbers are not given. As a possible explanation of this difference, it is suggested that the flies are probably

much more voracious during May than in the wet season, as it is believed that the greatest number of larvae are deposited in May. It is clear, however, that a seasonal change in the available food supply is probably also an important factor.

The most interesting portion of Mr. Eminson's report is that which deals with the parasites of *Glossina morsitans* which he has found. In a batch of 258 collected *Glossina* pupae, from one puparium there emerged, on the 21st June 1914, a wingless parasitic wasp of the genus *Mutilla*. It was observed that the wasp on emerging had broken open the puparium in precisely the same way as would the fly itself, so that a mere external examination of the case would not reveal the fact that the fly pupa had been parasitised. On investigating a number of pupa-cases collected in the field, four were found to contain remains of parasitic pupae which were probably referable to the same species of *Mutilla*. On 21st August, 84 of the tsetse pupae were still unhatched, and 7 of them were therefore opened. Two of these contained larvae of the parasite, and in the other five the fly pupae had died from other causes. From the 77 remaining puparia 2 males and 8 females of the *Mutilla* were bred out between the 2nd and 6th September.

Specimens of both sexes of the *Mutilla* were forwarded by Mr. Eminson to the Imperial Bureau of Entomology for identification, but unfortunately these were lost in the post. However, Mr. H. Dollman, a colleague of Mr. Eminson's, forwarded about the same time to the British Museum a single female of what is doubtless the same insect. This is described below by Mr. R. E. Turner as a new species, under the name of *Mutilla glossinae*.

In addition to the foregoing parasite, Mr. Eminson obtained, on 21st August, 35 specimens of a Chalcid from a single tsetse pupa. The species has not been forwarded for identification, and it remains to be seen whether it is a true parasite or merely a harmful hyperparasite. Of 80 collected pupa-cases 3 had apparently been attacked by the same Chalcid.

A NEW SPECIES OF MUTILLA PARASITIC ON GLOSSINA MORSITANS.

By R. E. Turner.

Mutilla glossinae, sp. nov.

♀.—Nigra; thorace rufo-ferrugineo; segmentis dorsalibus primo secundoque apice bruneotestaceis, albo-fimbriatis; tertio etiam albo-fimbriato.

Long. 5·5 mm.

♀.—Head and abdomen very closely and rather strongly punctured; dorsal surface of the thorax punctured-rugose, pleurae closely but more finely punctured. Head much narrower than the thorax, rounded at the posterior angles, the posterior margin straight; eyes oval, situated nearer to the base of the mandibles than to the posterior margin of the head; antennal tubercles blunt, second joint of the flagellum no longer than the third; mandibles acute, without a tooth on the inner margin. Thorax robust, scarcely longer than the greatest breadth, a little narrower at the apex than at the base, the sides rather strongly convex. First dorsal segment short

Mutilla glossinae, sp. n.

and broad, not petiolate; second as broad as long, very feebly constricted at the base, the apical bands of white pubescence on the two basal dorsal segments are narrow, not interrupted, and slightly broader in the middle than at the sides; the apical band on the third segment is very narrow. Pygidial area not very clearly defined, shining and sparsely punctured. Carina of first ventral segment obliquely truncate at the apex; second ventral segment coarsely punctured. Hind tibiae with a row of four spines on the outer side.

N.W. Rhodesia: Mwengwa (*H. Dollman*).

In colour and in the distribution of pubescence this species resembles *M. taygete*, Pér., but it is easily distinguished from that species by the much greater breadth of the thorax and first abdominal segment, and the smaller head.

COLLECTIONS RECEIVED.

The thanks of the Imperial Bureau of Entomology are due to the following gentlemen, who have kindly presented collections of insects (received between 1st July and 30th September, 1914):—

Dr. W. M. Aders:—1 *Anopheles mauritianus*, Grp., from Zanzibar.

Rev. Jas. Aiken:—1 Stratiomyid fly, 3 *Cimex*, and 2 Ticks; from British Guiana.

Dr. C. H. Allan, W.A.M.S.:—5 Culicidae, 19 *Tabanus*, and 12 *Glossina palpalis*; from Bonthe, Sierra Leone.

Mr. T. J. Anderson, Government Entomologist:—81 Culicidae, 4 *Haematopota*, 19 *Tabanus*, 12 *Glossina*, 11 other Diptera, 5 Hymenoptera, 44 Coleoptera, 13 Lepidoptera, 1 Planipennia, 14 Rhynchota, 2 Odonata, and 12 Orthoptera; from British East Africa.

Mr. E. Ballard, Government Entomologist:—1804 Diptera, 267 Coleoptera, and 89 Rhynchota; from Coimbatore, South India.

Dr. Richard A. Bolt:—9 *Phlebotomus*; from Peking, China.

Mr. John R. Bovell, Superintendent of Agriculture:—5 Hymenoptera, 22 Coleoptera, and 2 Slides of Coccidae; from Barbados.

Mr. J. H. Burkill:—4 Tingid Bugs; from Singapore.

Mr. d'Emmerez de Charmoy, Government Entomologist:—22 Moths, 1 Weevil, and 4 Fulgoridae; from Mauritius.

Mr. E. B. Connell:—3 Tabanidae, 6 other Diptera, and 1 Pompilid Wasp; from Trinidad.

Division of Entomology, Pretoria:—4 Oestrid larvae, 3 other Diptera, 31 Coleoptera, 9 Rhynchota, and 10 Orthoptera; from the Transvaal.

Mr. F. Evans:—131 Lepidoptera; from Calabar, Southern Nigeria.

Dr. Lewis H. Gough, Government Entomologist:—51 Hymenoptera, 15 Lepidoptera, 12 Rhynchota, and 10 Orthoptera; from Egypt.

Mr. C. C. Gowdey, Government Entomologist:—3 Diptera, 65 Hymenoptera, 459 Coleoptera, 13 Lepidoptera, 1 Mantispid, 6 species of Coccidae, 18 Psyllidae, 128 Aphididae, 246 other Rhynchota, 48 Orthoptera, and 12 Ticks; from Uganda.

Mr. Gerald F. Hill, Government Entomologist:—63 Diptera and 3 puparia, 3 Siphonaptera, 96 Hymenoptera and 1 cocoon, 5 Coleoptera, 3 Lepidoptera, 4 Planipennia, 14 species of Coccidae, 80 other Rhynchota, 12 Odonata, 27 Thysanura, and 5 Mites; from the Northern Territory, Australia.

Mr. E. Hutchins, Chief Veterinary Officer:—26 *Haematopota* and 4 *Tabanus*; from Toro District, Uganda.

The Imperial Institute:—2 Coleopterous larvae; from Fernando Po.

Dr. W. A. Lamborn:—128 Diptera, 13 Hymenoptera, 178 Coleoptera, 1 Moth, 30 Rhynchota, 9 Odonata, and 2 Ticks; from Dahomey.

Dr. N. Leys, M.O.:—1 *Pangonia*, 9 *Dorcaloemus*, 5 *Haematopota*, 2 *Tabanus*, 1 *Auchmeromyia*, 191 other Diptera, 12 Hymenoptera, and 9 Lepidoptera; from Karonga, Nyasaland.

Dr. Harold Macfarlane, Government Bacteriologist:—9940 Culicidae; from Hong Kong.

Dr. R. E. McConnell, M.O.:—25 Culicidae, 17 *Haematopota*, 2 *Tabanus*, 13 *Glossina*, 8 *Stomoxys*, 4 *Lyperosia*, 2 Hippoboscidae, 3 other Diptera, 2 Hymenoptera, 5 Coleoptera, 1 Lepidopteron, a number of Aphididae, 1 Orthopteron, and 16 Ticks; from Uganda.

Dr. H. B. Owen, M.O.:—2 *Tabanus*, 4 *Hippocentrum*, 2 other Diptera, 1 Hymenopteron, 5 Coleoptera, 10 Lepidoptera, 2 Planipennia, and 5 Rhynchota; from Uganda.

Dr. J. S. Pearson, W.A.M.S.:—4 Culicidae, numerous Culicid larvae and pupae, 1 tube of *Ceratopogon*, 3 *Haematopota*, 32 *Tabanus*, 8 *Stomoxys*, 147 *Glossina*, 1 Asilid, 1 Beetle, 6 Rhynchota, 1 Orthopteron, and 28 Ticks; from Sierra Leone.

Dr. A. C. Rendle, M.O.:—2 *Hippocentrum*, 40 *Haematopota*, 6 *Tabanus*, 72 *Glossina*, and 10 other Diptera; from Uganda.

Mr. A. Rutherford, Government Entomologist:—5 Culicidae, 22 other Diptera, 20 Hymenoptera, 99 Coleoptera, 2 Orthoptera, 91 Thrips, and 1 Spider; from Ceylon.

Captain H. F. Sproston, Travelling Commissioner:—4 Culicidae, 1 *Tabanus*, and 5 *Glossina*; from Bathurst, Gambia.

Dr. H. S. Stannus, M.O.:—31 Culicidae, 1 *Tabanus*, 2 cases of Asilids and prey, 235 other Diptera, 157 Hymenoptera, 62 Coleoptera, 44 Lepidoptera, 18 Lepidopterous pupae, 4 Chrysopidae, 71 Rhynchota, 4 Odonata, and 24 Orthoptera; from Zomba, Nyasaland.

Dr. G. C. Strathairn:—80 Culicidae; from Uganda.

Mr. C. Strickland:—2 Anopheline Mosquitos with Arachnid parasites; from Kuala Lumpur, Federated Malay States.

Mr. Morris N. Watt:—4 Diptera and 6 Hymenoptera; from Wanganui, New Zealand.

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